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DEPARTMENT OF THE INTERIOR

CANADA

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REPORT

OF THE

TRIANGULATION

OF THE

RAILWAY BELT OF BRITISH COLUMBIA

BETWEEN

KOOTENAY AND SALMON ARM BASES

Surveyed by P. A. Carson, D.L.S. and M. P. Bridgland, D.L.S.

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ERRATA.

Pages 31 to 41 and 71 and 72.....The data upon which the latitudes and longitudes are based, and the corrections necessary to reduce them to the Dominion lands system are explained in the Appendix on pages 80 and 81.

Page 40.....Longitude of Fly, for 118° 27′ 09″·53 read 119° 27′ 09″·53

Page 41.....Latitude of Bonn, for 51° 50′ 39″·90 read 51° 15′ 39″·90.

Page 44.....Omit last paragraph and diagram. A new connection of Amyot to Dominion lands system posts has recently been made, and is included in the table on page 51.

Page 46.....Last line should read 255 − 176 = 79 links in latitude, and 3 + 62 = 65 links in longitude.

Pages 58 and 59.....For North Fork of the Spillimacheen river read Spillimacheen river.

For Middle Fork of the Spillimacheen river read Bobbie Burns creek.

Page [illegible].....Last line, for Beaver creek read Quartz creek.

Page [illegible].....Line 12, for Loop creek read Loop brook.

Last line, for Cygnus lakes read Bush lakes.

Page 61.....Line 34, for Gold creek read Gold river.

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TRIANGULATION OF THE BRITISH COLUMBIA RAILWAY BELT BETWEEN THE KOOTENAY AND SALMON ARM BASES.

By the terms of the Union of 1871, under which the Crown Colony of British Columbia joined Confederation, the Canadian Government undertook to secure the commencement within two years, and to complete within ten years, a railway over the Rocky and Selkirk mountains; the railway to be one continuous line connecting the seaboard of British Columbia with the Canadian Pacific railway then under construction on the western prairies: and in consideration thereof the British Columbia Government were to cede to the Dominion a belt of land to extend twenty miles on each side of the proposed railway when built.

From 1871 to 1880 the work of exploration and construction was undertaken by the Government, with Sir Sandford Fleming as Chief Engineer. In 1880, however, the work was transferred to a private company, subsidized by the Government, the proposed route changed to the present Canadian Pacific route, and the work pushed to completion by the end of the season of 1885.

The Railway Belt could now be defined as comprising that belt of land within twenty miles of the Canadian Pacific railway. Among the mountains of British Columbia it was evidently impossible to define the limits so that they should be everywhere a distance of twenty miles from the railway, and it was subsequently agreed that the limits of the belt should be defined by the nearest section lines to the theoretic boundary.

There were two methods available for the survey and subdivision of this forty-mile belt of land; either to lay out isolated township, settlement, or group lots wherever and whenever needed, or to follow the regular system of rectangular townships developed and extended over the great plains to the east.

The disadvantages of the former and advantages of the latter system are sufficiently obvious to justify the adoption of a rectangular system which should be uniform with the survey of all Dominion lands, and the system of survey for the lands included in the Railway Belt as finally decided upon was a slight modification of the third system of survey of Dominion lands. The modification consists in adding to each quarter section of 160 acres, an allowance of 3 acres for roads instead of locating the roads along section lines. This allowance is provided for by making the dimensions of each quarter section 40 chains and 50 links on the base lines, and on the meridians 40 chains and 25 links. The dimensions of the townships are therefore the same as those in the third system, namely 483 chains north and south and 486 chains east and west, and the theoretic township boundaries are uniform with those of the third system.

As the very mountainous nature of the country of the Railway Belt precludes any idea of running the meridians and base lines on which the Dominion lands system of survey is dependent for its uniformity, some other method of survey had to be provided as a base for further subdivision work. For this

purpose, an accurately conducted traverse or deflection survey of the railway was made. The traverse was run easterly from Port Moody to Revelstoke by William Ogilvie, D.L.S., in 1885; by Thomas Fawcett, D.T.S., in the same year, from a point near Calgary to the summit of the Rocky mountains in range 17 west of the fifth meridian; and the intervening portion from the summit of the Rocky mountains westerly by Otto J. Klotz, D.T.S., in 1886, connecting with the western portion of the traverse at Revelstoke. Observations for latitude and longitude were taken at the terminal points, Calgary and Port Moody, and at intermediate points at Kamloops, Revelstoke, and Field.

At the completion of the traverse, it was found that in the 640 miles of survey, necessitating more than 3,500 instrument stations, the error in longitude was only two chains, this including the determinations of longitude at the terminal points. In latitude there was a closing error of about twenty chains between the two parts of the traverse, which appears to be principally due to the abnormal deviations of the vertical producing unavoidable errors in the observations at the terminal points. This discrepancy is allowed for by a jog of 20·62 chains on the sixth merdian.

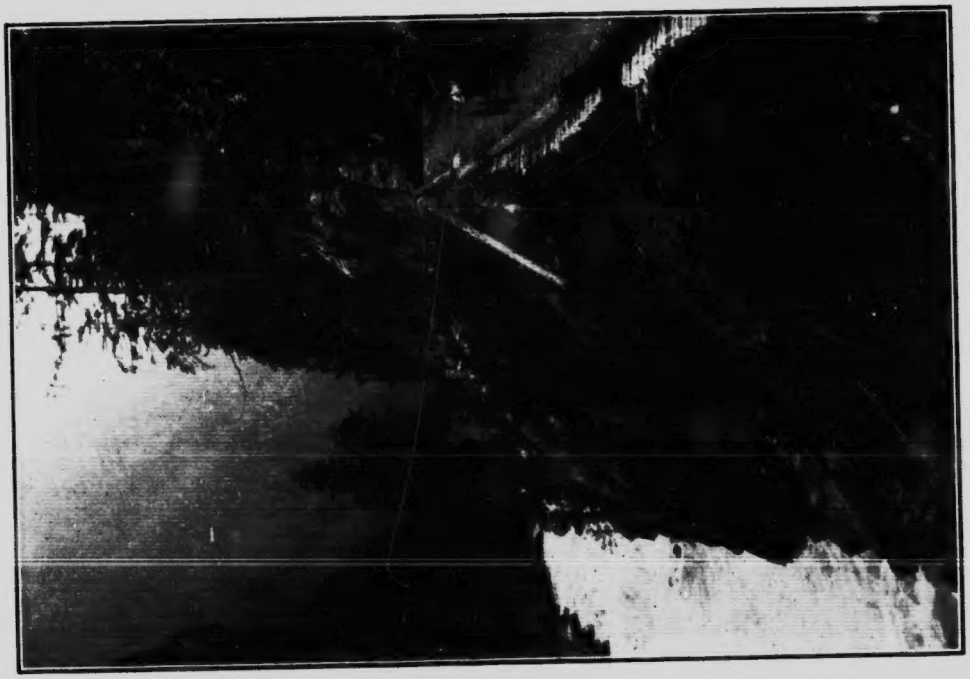
During the traverse, reference marks were cut on telegraph poles, to serve as permanent marks from which subdivision surveys could be started. They were marked with the letters C.P.T. (Canadian Pacific Traverse) and the number of the reference mark in Roman numerals. By computing the latitudes and longitudes of these posts, their positions in the Dominion lands system became known; and they and the subdivision posts planted from them, have served as a base for subdivision until recent years. On account of repairs and alterations to the track and line, however, there are now but few C.P.T. posts remaining in their original positions.

With the advancing of settlement, need was found for surveys in isolated valleys at some distance from the railway, and it was often necessary to run many miles of traverse over rough country, a method both costly and objectionable. Hence it was found desirable to establish by triangulation a number of permanent marks whose positions are accurately known relative to the framework of the Dominion lands system of surveys. Such marks could then be used as convenient reference points for the commencing of isolated surveys, and the tying to the Dominion lands system of mineral claims, timber berths, and other reservations.

To serve this purpose it is imperative that the triangulation survey should be indisputably of greater accuracy than the work it is to control; and in this survey an ample degree of precision has been attained without proceeding to any of the expensive refinements necessary for a triangulation of a primary or geodetic nature.

The triangulation in the Railway Belt of British Columbia has been carried out by Mr. P. A. Carson, D.L.S., and Mr. M. P. Bridgland, D.L.S. Mr. Carson's work comprises the eastern part of the triangulation extending westward from the Alberta-British Columbia boundary and embracing an area of approximately 3,000 square miles. The western part of the triangulation was done by Mr. Bridgland. It extends westerly from Mr. Carson's work to Shuswap lake, and embraces an area of approximately 2,000 square miles.

In the Incomappleux valley near Cambourne.



In the Incomappleux valley near Cambourne.

BASE LINES.

The triangulation was controlled by two accurately measured bases. A good site was selected for a base line at the easterly end of the net, in the Kootenay valley about twenty-one miles above the town of Golden. The base line, as established, is a little over five and one-quarter miles in length, and lies along the right bank of the Columbia river, several times crossing the wagon road in township 24, ranges 19 and 20, west of the fifth meridian. This base was measured by Messrs. Carson and De la Condamine in 1909, and a detailed description of the measurement may be found in a paper written by Mr. Carson on "Precise Measuring with Invar Wires and the Measurement of the Kootenay Base." This paper appears in the annual report of the Topographical Surveys Branch for 1909-10, and has also been published in pamphlet form.

The base at the western end of the triangulation is situated in township 20, range 10, west of the sixth meridian, and runs close to the town of Salmon Arm. This base, which is a little over five miles in length, was measured by Messrs. Bridgland and De la Condamine in 1912 by apparatus and methods similar to those described by Mr. Carson.

The method of measuring these bases follows closely that laid down by J. René Benoit and Ch. Ed. Guillaume in their book "La Mesure Rapide des Bases Géodésiques." The apparatus used in the measurements consisted of two invar wires, six tripods of special design as described in the above mentioned book, two straining trestles, a small level of special design, together with such auxiliary instruments as transit, level, and steel tapes.

The invar wires which are numbered 272 and 273 are about $1 \cdot 7^{mm}$ diameter and twenty-four metres long, are joined at each of their ends to invar scales which are about eight centimetres long and graduated to millimetres. Each scale is attached to the wire by a bolted piece to which it is screwed and riveted so that the edge of the graduated scale is in a direct line with the neutral axis of the wire. The wires were twice tested and standardized at the International Bureau of Weights and Measures, Sevres, France, the dates of testing and measuring being:—

1908, Feb.—Special annealing process commenced.
1908, Nov.–Dec.—Wires standardized at Sevres.
1909, Oct.–Nov.—Wires used for the measurement of the Kootenay base.
1910, Sept.–Nov.—Wires standardized at Sevres.
1912, Oct.–Nov.—Wires used for the measurement of the Salmon Arm base.

Each tripod consists essentially of a bolt bearing the datum or measuring mark and mounted on a movable plate fitted with levelling screws and plate level. The bolt is fitted with a plumb-bob attachment, accurately centred, so that the datum mark may be quickly centred over a point in the ground. The top of the bolt is composed of a hard white alloy which will not oxidize, and has a bevelled edge cut at the same angle as a cross section of the end scales of the wires, permitting the graduations to coincide with the horizontal plane of the datum mark.

The straining trestles are simply tripods having one of the legs replaced by a long leg, to which is attached a pulley. The pulley is mounted on ball bearings so that friction will be reduced to a minimum.

In preparing the bases they were cleared of all timber, grass, and bush for a width of about six feet, large stumps being sawn off level with the ground. Hubs were set at a distance of about twenty-four metres apart for the whole length of the base, the alignment being made by transit. A forward line was run so that the errors of alignment would be very small. The general principle of the measurement was to set up tripods over these hubs, the tripods being as nearly as possible on the line, and then the distance between the tripods accurately measured with the invar wires. The end scales of the wires are each eight centimetres long, so that provided the tripods are on line no very accurate setting is required. With a little care the datum mark could be centred by plumb-bob to within half a millimetre of the line, and this was sufficiently accurate.

Each base was divided into sections, a section being approximately a day's measurement, the extremities being marked by special iron bolts having a fine cross on their heads, and fitted with a centering device. The measurements for each section could then be compared, and several closing checks obtained in each base, from which a probable error of the measurements may be computed. The tripods were accurately centred over these terminal marks of the sections by transit, making four settings of the datum mark on the tripod head on each occasion, two with the transit "circle right" and two "circle left."

The tension was applied by two 10-kilogram weights attached to the ends of the measuring wire by ordinary window-sash cord, which passed over the ball-bearing pulleys.

In order to facilitate the rapid progress of the measurement, each member of the party was drilled in his special work; by this means the tripods and straining trestles were quickly and accurately centred by practised men in advance of the measuring party, and the observers were seldom delayed. When in position the wire suspended from the straining trestles should have its end scales close to the heads of the tripods, so that by a slight lateral pressure of the finger, the scales could be pressed against the tripod heads and simultaneous readings taken by the observers of the position of the measuring marks against the end scales of the wires. Five such pairs of readings were taken to determine the length of each span, but were rejected if they showed a discrepancy of more than $0{\cdot}3^{mm}$ in the length of the span; this, however, was seldom the case. Before each reading the wire was slightly disturbed and allowed to settle, in order to guard against any friction of the pulleys and cords unduly increasing or diminishing the tension of the wire.

The leveller immediately followed the observers and recorded the slope between the heads of the consecutive tripods. In setting the tripods, care was taken to reduce the slope as much as possible, and it was sometimes necessary to set up a tripod on hubs, or to set up very low by making excavations for the tripod legs; with these precautions the slope seldom exceeded five per cent.

The slopes between the measuring marks on the consecutive tripod heads were estimated to 0·01 per cent, and two corrections applied to reduce the

measured length to the horizontal; the first, a slope correction, and the second, a correction due to the alteration in the tensions and form of the curve of the wire when the supports are not at the same level. These corrections are tabulated for different slopes in tables IV and V in the appendix of "La Mesure Rapide des Bases Géodésiques."

For a more detailed description of the measurement of these bases, reference should be made to Mr. Carson's paper on the subject.

In considering the uncertainty in the final lengths of these bases, the errors in the accepted lengths of the wires are of primary importance since they are of constant or systematic nature. These errors are dependent upon the standardizations at Sevres, and the actual variations of the wires between the times of standardizing and the actual measurements. The probable error of a standardization of a wire at Sevres may be taken at about 1 in 2,500,000 or less, so that the probable errors in the base measurements from this cause would be only about two or three millimetres. Changes in the lengths of the wires can only be estimated from the results of the two standardizations and the comparisons of results obtained by tests and measurements in the field.

When the wires were returned to France to be retested after the Kootenay base measurement, it was found that the wire numbered 273 had responded well to the curve provided by the International Bureau. This curve gives the lengthening, with time, of invar which had been subjected to the same processes of drawing and annealing as the wires under consideration. Hence the measurement by wire No. 273 was accepted in the Kootenay base measurement, the other measurements acting only as checks. This measurement differed from the mean of the three measurements of the base of 8,565 metres by 3^{mm}, the range of the three measurements being only $5 \cdot 6^{mm}$.

In the Salmon Arm base, two measurements were made with each wire, the lengths as given by each wire differing by $11 \cdot 5^{mm}$. In this case there was no satisfactory evidence to show that either wire was more reliable than the other, and the mean was taken.

The probable error due to the measurements may be computed from the different readings taken in the field. The magnitude of these are: for the Kootenay base $\pm 1 \cdot 8^{mm}$, and for the Salmon Arm base $\pm 1 \cdot 2^{mm}$. These errors do not fully consider the errors due to such causes as the slight irregularities in the tension of the wires due to friction of the cords and pulleys and the consequent changes in the sag and strain of the wires, errors due to inaccuracies of the slope corrections, and errors due to uncertainty in the temperature of the wires. By the observing of every precaution consistent with reasonable progress, it is expected that these errors are not of any magnitude, comparable with the larger errors investigated. Thus work was suspended during unsuitable weather when the dampness would sensibly affect the flexibility of the cords over the tension pulleys, or the moisture collecting on the wire would affect the sag. Small errors in ascertaining the correct temperature of the wire during measurement could produce but a very slight error as the coefficient of dilatation of the wires was exceedingly small, namely,—$0 \cdot 121 \times 10^{-6}$ per degree Centigrade. It is interesting to note that the coefficient of expansion for these wires is negative, the wires contracting slightly with rise of temperature. In

the Salmon Arm base, which was measured under a greater range of tempera ture than the Kootenay base, the temperature varying from 1° C. to 24° C., th maximum temperature correction to the length of the base was only 7^{mm}. liberal estimate of the probable errors in the final lengths from this cause woul be 1^{mm}.

The difference between the effects of terrestrial gravity at Sevres, France where the wires were standardized and at either base, is so small that th resulting change in tension due to the 10-kilogram weights does not appreciabl affect the measurements.

In reducing the lengths of the bases to sea-level, difficulties were met wit such as are inevitable in all surveys of precision in a district isolated from othe surveys of a precise nature. In the present case the nearest precise levels wer some 180 miles distant, and it was not practicable at the time to extend thes levels to the base lines; neither was it necessary for the progress of the presen work. To obtain a requisite degree of accuracy in the measurement of thes bases, special apparatus and methods of measuring were necessary, and by th expenditure of but little extra time and care in the field the lengths on the groun have been determined with a degree of precision consistent with geodetic wor of the highest class. Before any system of primary triangulation is require over this region, lines of precise levels will have been run along the railwa lines in this vicinity, and the information will then be available for an accurat estimate of the correction to sea-level.

To illustrate the importance of an accurate determination of the altitud it may be mentioned that an error of ten feet in the mean altitude of one these bases would give rise to an error of about 4^{mm} in the final correcte length of that base.

For the present purpose the nearest elevations obtainable were the Ca adian Pacific railway levels, from which connections were made to several the triangulation stations. These data were used for the reduction of the base to sea-level and, although no correct estimate can be formed of their accuracy they may certainly be expected to be less than twenty feet in error, correspondin to an error of less than 8^{mm} for each base, due solely to the uncertain altitude.

Considering all these sources of error, a conservative estimate of a probab error for each base would be less than 10^{mm}, or an accuracy of approximatel 1 in 800,000. In comparison, therefore, with the errors of the angular measur ments, the errors in the base measurements may be considered inappreciabl

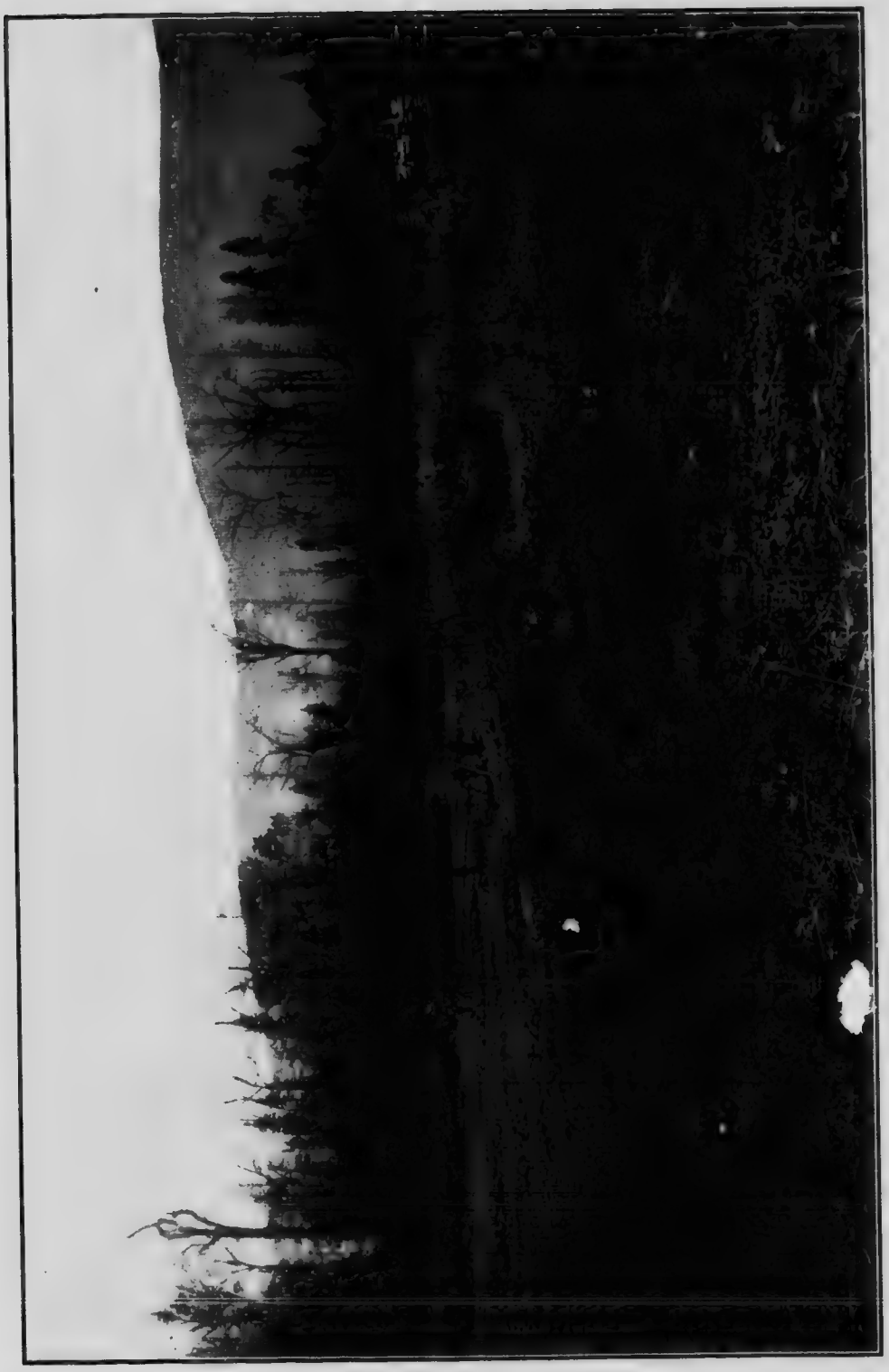
The final accepted lengths of the bases reduced to sea-level are:—

For the Kootenay base, 8,565·574 metres;

For the Salmon Arm base, 8,174·652 metres.

MARKING OF STATIONS.

The permanent mark used in this survey to denote the geodetic point is brass bolt six inches long and three-quarters of an inch diameter, with a fl square head one and one-half inches square and one-half inch thick. This bo is set in a hole drilled in the rock, and is firmly fixed with cement. The hea of the bolt is stamped with a triangle having its vertex at the centre of th



Measuring the Salmon Arm base.

head of the bolt, and facing north. The geodetic point is at the centre of the head of the bolt. The head of the bolt is also stamped with a number in Roman numerals or the letters T.S. As reference points for accurately determining the position of the permanent mark, iron bolts are set in holes drilled in the rock and fixed with cement, their positions and distances from the geodetic point being noted.

The signals for observing upon were usually conical stone cairns raised vertically over the geodetic point, their average dimensions being about six to eight feet in diameter at the base, about two feet diameter at the top, and from six to ten feet high. White cotton wrapped around the cairn, or a sheet of tin in the form of a truncated cone surmounting the cairn, served to aid as a signal.

The lengths of sights were usually between fifteen and twenty-five miles and, with the telescope of the theodolite used, excellent bisections could be made upon conical stone cairns from six to eight feet high. When a cairn on a distant mountain peak stood out against the sky line, the pointed top of the dark mass of the cairn could easily be sighted upon, but where a pointing was made from a higher to a lower mountain, and the distant cairn had a dark background, the assistance of a band of white cotton wound around the cairn about a foot from the top was found most servicable. Tin signals in the form of truncated cones placed on the top of the cairns were not found satisfactory; only on rare occasions was reflected light received from these signals, and never from more than one at a time. The tin, too, becomes rusted after a season's exposure.

On the lower hills, where no loose rock was available, a timber framework was erected to serve as a signal.

ANGLE READING.

The instrument used for the observing of horizontal and vertical angles, and for azimuth observations, was a direction theodolite made by Messrs. T. Cooke & Sons, of York, England. The telescope has a focal length of fifteen and one-half inches, and the objective a clear aperture of two inches. The eyepiece chiefly used has a magnifying power of thirty diameters. The six-inch horizontal circle is graduated to 0·25 degree, and the readings made by two micrometer microscopes of high magnifying power with two parallel vertical spider threads. Five revolutions of the micrometer correspond to one division of the horizontal circle, so that each revolution represents 0·05 degree. The milled head of the micrometer is divided into fifty divisions so that each division is equal to 0·001 degree or 3·6 seconds of arc, and the observer can easily interpolate to parts of a division.

The theodolite was mounted on a short tripod, about two feet high, rigidly braced with cross-pieces screwed to the legs. Wherever possible the instrument was set up on solid rock, sometimes using an eccentric station for that

The transit alone weighs 20 pounds. When packed with its accessories, in two boxes, it provides two packs of 29 pounds and 20 pounds respectively. The weight of the tripod is 12 pounds.

purpose, and small holes were chiselled in the rock to take the metal-moun points of the tripod legs.

The usual method of observing was as follows: after setting up and levelli the "A" micrometer was set at zero, and the telescope set approximately on zero station or initial point, by the lower tangent screw, the final pointing be made by the finer threaded upper tangent screw, and the micrometers re The other signals were then read in rotation, closing finally on the initial stati The error in closing seldom exceeded one division of the micrometer drum (3" and when excessive the set was rejected. The upper circle was then advan by 45°, 90°, and 135°, and three more sets of readings taken; the microme screw was advanced by one turn for each set by Mr. Carson, and by one an quarter turn by Mr. Bridgland. By this method each angle was read o different parts of the circle, and different parts of the micrometer screw w used in the several measurements of each angle, thus tending to minimize a errors due to the irregularities of the graduated circle and micrometer scre The axis of the telescope was then reversed in its wyes and readings taken w the "A" microscope at 180°, 225°, 270°, and 315° starting with the microme drum at zero and advancing as before. Half of the observations were ma with the telescope moving in the clockwise direction from the zero statio and half with the telescope moving in the reverse direction. This meth of procedure gives a set of eight readings for each direction.

Whenever time allowed, Mr. Bridgland advanced his upper circle intervals of 30° and the micrometer by five-sixths of a turn for each round readings instead of 45° and $1\frac{1}{4}$ turn as above. This gave a set of twelve readin for each direction.

The difference of the initial and final readings on the zero station w usually small and well within the limits of accuracy for pointing and readin In such cases the mean was accepted as the correct reading on the initial poin When the closing error was considered too large the round of readings w rejected and repeated.

Owing to the exposed nature of the mountain peaks on which nearly a of the triangulation stations were situated, great difficulties to satisfactor observing were encountered. Thus it was impossible to observe as early or a late in the day as desirable, as the long and often hazardous climbs necessitat so many hours of daylight being reserved for the ascent and descent, whil the variable weather conditions rendered it necessary that no tim at a station be wasted when observing was possible. In general, on the highe peaks the surveyors made it a rule to employ the whole time available at station to the best advantage. Under these conditions the horizontal direction were read as early and late in the day as possible, and the vertical angle about noon, when the effects of horizontal refraction are a minimum.

Usually on the lower peaks where any timber was available, the instrumen was sheltered from the sun and from the wind, if strong. A few minutes spen in erecting a sunshade and wind-shield were more than repaid by the gre ease and rapidity in reading the micrometers, besides reducing the errors due t unequal heating of the parts of the instrument.

Below is given a brief summary of the readings at the three stations Carnes Mara, and Griffin, as examples of the discrepancies and closings usually met with in the angular measurements.

SUMMARY OF DIRECTIONS AT CARNES STATION.

Two sets of readings were taken, each set consisting of eight readings on each station, taken circle right and circle left, and with forward and backward motion as described. The two sets were taken on the same day, the first between 10.30 and 11.15 a.m., with initial microscope readings at 0°, 45°, etc., and the second set between 1.10 and 2.30 p.m., with initial circle readings of 22½°, 67½°, etc.

The differences between the initial and final readings on Albert for the means of the two sets were +0″.11 and −0″.81 respectively, and in each case the mean of the initial and final readings on Albert was accepted as correct.

When reduced to Albert as zero station the means were as follows:—

Station.	Directions.			
		Means of first set.	Means of second set.	Accepted Means.
	° ′	″	″	″
Albert	0 00	00·00	00·00	00·00
Copeland	68 05	14·49	21·42	17·96
Cornice	297 28	44·08	42·44	43·26

At Carnes station, an eccentric station was used and a further correction to these directions is necessary to reduce them to the geodetic point.

SUMMARY OF DIRECTIONS AT GRIFFIN STATION.

Directions were read at Griffin station in 1911 and 1912, the horizontal circle being advanced by intervals of 30° and the micrometer drum by five-sixths turn as described, giving twelve readings around the circle in 1911; and by 45° and 1¼ turns, respectively, giving eight readings around the circle in 1912. The conditions, however, were rather better in 1912 than in 1911, so that the means of the two sets were given equal weights in obtaining the final directions. The differences between the mean initial and mean final closing readings on Mabel were +0″.56 and −2″.23 respectively.

Station.	Directions.			
		1911 Readings.	1912 Readings.	Final Means.
	° ′	″	″	″
Mabel	0 00		00·00	00·00
Mara	44 52		52·79	54·11
Queest	102 02		35·34	36·37
Copeland	200 52		07·78	06·76
Begbie	279 31	35·79	36·00	35·90

SUMMARY OF DIRECTIONS AT MARA STATION.

Directions were read at Mara in 1911 and on two different occasio
1912. On one of these occasions a different transit was used—a Trought
Simms three vernier six-inch instrument reading to 20″.

Station.	Directions.						
			Cooke Transit.			T. & S. Transit	Fi Weig Mea
			1911 Mean of 8 readings.	1912 Mean of 8 readings.	1912 Mean of 6 readings.	1912 Mean of 4 readings.	
	°	′	″	″	″	″	″
Queest	0	00	00·00	00·00	00·00	00·00	00
Griffin	47	18	24·18	26·65		22·71	24
Mabel	113	59	01·02	02·09		00·63	01
Sugarloaf	54	56	28·66	28·56			28
Ida	245	21	19·19*	24·79	23·99	20·62	23
Fly	265	02		07·29		03·54	06
Granite	268	46	03·53	04·44			03
Bastion	294	11		11·42	02·80	06·77	07

*These readings on Ida were taken under unfavourable conditions and were rejected.

OBSERVATION WORK.

Azimuth observations were taken at several stations, the usual metho
observing on Polaris being followed. The instrument was always set up fir
on solid rock and sheltered from the sun. After careful levelling up, a rea
on the reference object was taken, and then on Polaris; the face of the ins
ment was then reversed and sightings taken on Polaris and again on the refere
object. The stride level was read immediately on making each pointing
Polaris and was then reversed and re-read. The value of one division of
stride was 3″.3.

Usually eight such sets of readings were taken, different parts of the ci
and micrometer screw being used, as with the angular measurements.
Carson's observations were taken at subsidiary stations which were tied in
the main triangulation by a series of triangles, but Mr. Bridgland's us
practice was to observe at primary stations, using another primary station
reference object.

As the meridian was always approximately known, the time was determi
by the transits of two or more stars across this meridian, and a slight correct
afterwards applied, if necessary.

Two observations for latitude were made at the western end of the trian
lation, by Mr. J. A. Fletcher, D.L.S., using a portable zenith telescope ma
by Troughton & Simms.

occasions in
Troughton &

	Final Weighted Means.
	"
0	00·00
1	24·88
1	01·37
	28·61
2	23·60
4	06·04
	03·99
7	07·38

rejected.

l method of
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o, a reading
the instru-
he reference
pointing on
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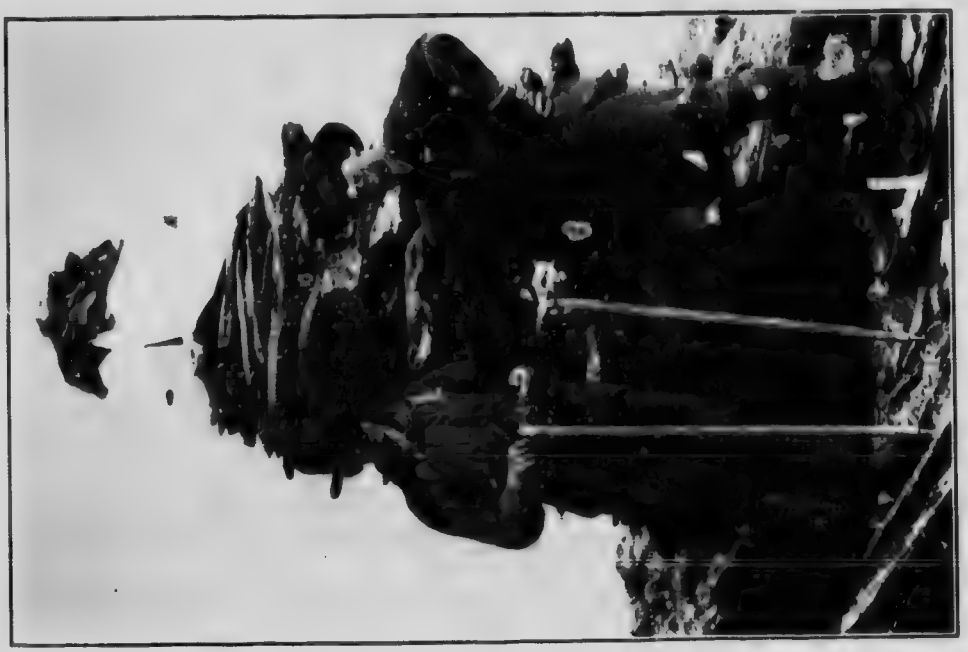
Cairn at Cherub station.



Cairn at Kapristo station.

The latitudes have been reduced to the geodetic points, and corrected to sea-level. The correction to sea-level is given by the expression:

Correction = $-0''\cdot000052$ H sin 2 L

where H is the altitude of the observation station.

For Salmon Arm H = 1,200 feet
and correction to sea-level = $-0''\cdot061$

For Sugarloaf H = 2,600 feet
and correction to sea-level = $-0''\cdot133$

For the reduced latitudes we have:

Latitude of north end of Salmon Arm base as deduced from latitude determination of eighty-seven observations on sixty-four pairs of stars = $50°\ 42'\ 50''\cdot98 \pm 0''\cdot07$

Latitude of Sugarloaf triangulation station as deduced from a latitude determination of ninety-five observations on sixty-four pairs of stars = $50°\ 38'\ 07''\cdot07 \pm 0''\cdot05$

The difference of astronomic latitudes between these two stations is therefore $4'\ 43''\cdot91$ with a probable error of about $0''\cdot1$. The geodetic difference of latitude, however, as calculated from the adjusted triangulation is $4'\ 38''\cdot70$ with a probable error which would not exceed $0''\cdot1$. The discrepancy of $5''\cdot21$, which is equivalent to a distance of 8·00 chains, must be considered as being due to the difference in the local deflections at the two places. In a country so rugged and mountainous as the Rocky mountains, where large deviations of the plumb line must be expected, the phenomenon of local attraction presents a very serious difficulty to the accurate determination of latitudes and longitudes, and in the absence of other more definite data the difference of $5''\cdot21$ has been divided equally between the two stations. This gives:

For the latitude of the north end of Salmon Arm base	$50°\ 42'\ 48''\cdot37$
For the latitude of Sugarloaf triangulation station	$50\ 38\ 09\ \cdot67$

The longitudes of the triangulation depend upon the longitude of a point in Revelstoke as determined from Vancouver by the Chief Astronomer of Canada in 1911. This point was tied in to the main triangulation net.

ADJUSTMENT OF THE TRIANGULATION.

The accuracy of the triangulation was not such as to warrant any rigid adjustment of the net as a whole, and it was considered sufficient to divide the main net into sections, each section being adjusted by the method of Least Squares. A diagram of the triangulation is shown (plate 1), the full lines representing the main net of the triangulation, the fine and broken lines representing the parts of a secondary degree of accuracy. All directions in the main net were of about equal weight, and consequently no weight constants were introduced into the adjustment.

The direction method of adjustment has been followed, where it is assumed that the errors are inherent to the separate directions, and the error in each observed direction affects every angle involving that direction. Hence the

most probable corrections to the different directions have been found, m
the usual assumption that all the errors involved are of the accidental cla

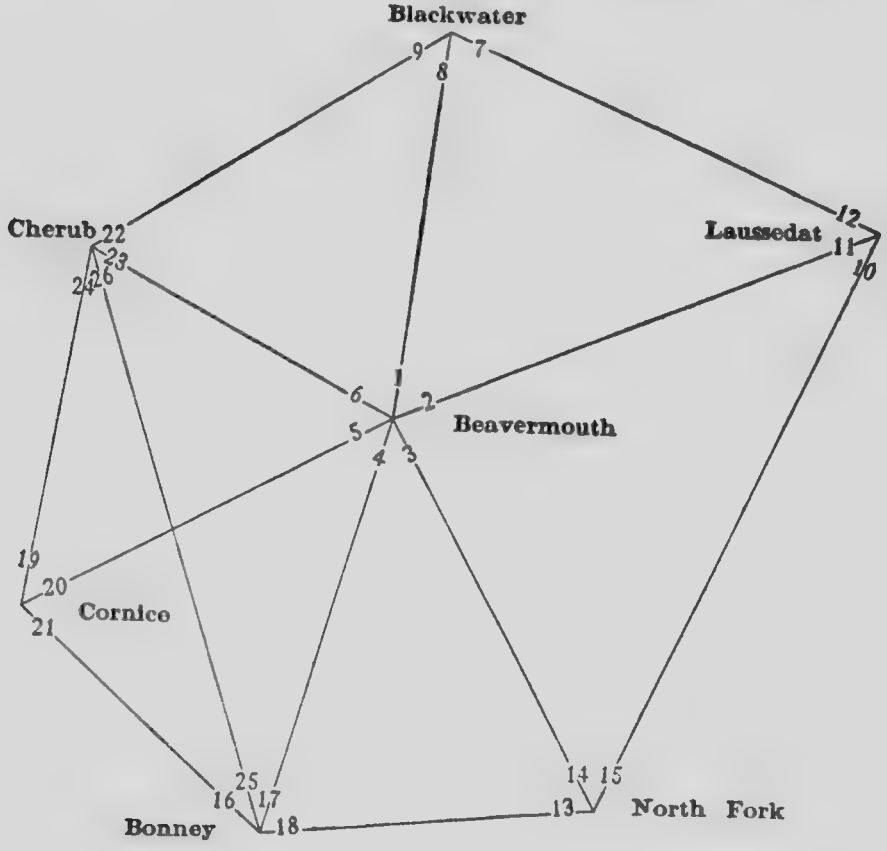
The adjustment of fig. 3 has been given to illustrate the method of a
ment followed.

In the accompanying figure each direction is denoted by a number, an
correction to that direction by the same number in brackets. The angle
their corrections appear only as the differences in the directions involved
their corrections. Thus the angles of the triangle Beavermouth, Ch
Blackwater are: 1 − 6, 23 − 22, 9 − 8, and the corrections to these a
(1) − (6), (23) − (22), (9) − (8).

In order that fig. 3 may be geometrically possible, the necessary and suffi
conditions are the satisfying of seven angle equations and two side equat
The angle equations may be written down immediately from the closin
the seven triangles selected. The spherical excess of each triangle is f
from the usual formula:

$$\epsilon = m\ ab \sin C$$

where m is a constant depending upon the mean latitude of the triangle
given in standard books of geodesy.



CLOSURE OF TRIANGLES.

			°	′	″
1.	Beavermouth	1 — 6	68	21	46·8
	Cherub	23 — 22	61	32	42·0
	Blackwater	9 — 8	50	05	30·3
			179	59	59·1
	Spherical excess				1·4
	Error of closure				− 2·3
2.	Beavermouth	2 — 1	60	56	01·9
	Blackwater	8 — 7	73	02	54·3
	Laussedat	12 — 11	46	01	10·0
			180	00	06·2
	Spherical excess				2·0
	Error of closure				+ 4·2
3.	Beavermouth	3 — 2	83	21	25·9
	Laussedat	11 — 10	43	06	50·0
	North Fork	15 — 14	53	31	53·2
			180	00	09·1
	Spherical excess				2·6
	Error of closure				+ 6·5
4.	Beavermouth	4 — 3	44	07	27·3
	North Fork	14 — 13	66	11	25·1
	Bonney	18 — 17	68	51	02·0
			179	59	54·4
	Spherical excess				1·5
	Error of closure				− 7·1
5.	Beavermouth	5 — 4	45	51	02·3
	Bonney	17 — 16	62	34	05·0
	Cornice	21 — 20	71	34	51·0
			179	59	58·3
	Spherical excess				1·2
	Error of closure				− 3·1
6.	Beavermouth	6 — 5	56	32	15·8
	Cornice	20 — 19	52	38	19·5
	Cherub	24 — 23	70	49	27·0
			180	00	02·3
	Spherical excess				1·3
	Error of closure				+ 1·0
7.	Cornice	21 — 19	124	13	10·5
	Cherub	24 — 26	26	32	59·0
	Bonney	25 — 16	29	13	52·0
			180	00	01·5
	Spherical excess				1·1
	Error of closure				+ 0·4

From the above triangles the angle equations are:

$$0 = -2\cdot3 + (1) - (6) + (23) - (22) + (9) - (8)$$
$$0 = +4\cdot2 + (2) - (1) + (8) - (7) + (12) - (11)$$

$0 = +6{\cdot}5 + (3) - (2) + (11) - (10) + (15) - (14)$
$0 = -7{\cdot}1 + (4) - (3) + (14) - (13) + (18) - (17)$
$0 = -3{\cdot}1 + (5) - (4) + (17) - (16) + (21) - (20)$
$0 = +1{\cdot}0 + (6) - (5) + (20) - (19) + (24) - (23)$
$0 = +0{\cdot}4 + (21) - (19) + (24) - (26) + (25) - (16)$

The side equations when reduced to the linear form are of the form:

$\delta_1 (M_1) - \delta_2 (M_2) + \delta_3 (M_3) - \ldots \quad + \log \sin M_1 - \log \sin M_2 + \ldots =$
where (M_1) (M_2) (M_3) .. are the most probable corrections to the angles M_1 M_3 ... and δ_1 δ_2 δ_3 ... are the changes in log sin M_1, log sin M_2, log sin M_3 .. for a change of 1″ in the angles M_1 M_2 M_3....

Considering first the side equation with Cornice as pole. The side equatio is:

$$\frac{\text{Cornice to Cherub}}{\text{Cornice to Beavermouth}} \times \frac{\text{Cornice to Beavermouth}}{\text{Cornice to Bonney}} \times \frac{\text{Cornice to Bonney}}{\text{Cornice to Cherub}} =$$

Substituting the sines of angles for the sides we get: $\dfrac{\sin (6-5)}{\sin (24-23)} \cdot \dfrac{\sin (17-16)}{\sin (5-4)} \cdot \dfrac{\sin (24-26)}{\sin (25-16)} = 1$
and reducing to the linear form:

$\delta' \{(6)-(5)\} - \delta'' \{(24)-(23)\} + \delta''' \{(17)-(16)\} - \ldots$
$+ \log \sin (6-5) - \log \sin (24-23) + \log \sin (17-16) - \ldots = 0$
where δ' δ'' δ'''... represent the differences in the log sines of the angles 6−5 24−23,...for a change of 1″.

The equation may be conveniently formed from the following table:—

Directions.	Uncorrected Angles.	Log Sines.	Differences for 1″.
	+ ve terms ° ′ ″		
6 − 5	56 32 15·8	$\bar{1}$·9212957	14
17 − 16	62 34 05·0	$\bar{1}$·9481971	11
24 − 26	26 32 59·0	$\bar{1}$·6502825	42
		7753	
	− ve terms ° ′ ″		
24 − 23	70 49 27·0	$\bar{1}$·9752089	07
5 − 4	45 51 02·3	$\bar{1}$·8558380	20
25 − 16	29 13 52·0	$\bar{1}$·6887166	38
		7[illegible]5	
		7753	
		+ 118	

and the reduced side equation is:

$$0 = +11\cdot8 +2\cdot0(4) -3\cdot4(5) +1\cdot4(6) +2\cdot7(16) +1\cdot1(17) +0\cdot7(23) +3\cdot5(24) - 3\cdot8(25) -4\cdot2(26)$$

the units being taken in the sixth place of logarithms.

For the second side equation the pole is taken at Beavermouth and the equation is:

$$\frac{\text{Beavermouth to Cherub}}{\text{Beavermouth to Blackwater}} \times \frac{\text{Beavermouth to Blackwater}}{\text{Beavermouth to Laussedat}} \text{ etc. . . } = 1$$

Substituting the sines of angles for the sides:

$$\frac{\sin(9-8)}{\sin(23-22)} \cdot \frac{\sin(12-11)}{\sin(8-7)} \cdot \frac{\sin(15-14)}{\sin(11-10)} \cdot \frac{\sin(18-17)}{\sin(14-13)} \cdot \frac{\sin(21-20)}{\sin(17-16)} = 1$$

Reducing as before we get for the reduced side equation:

$$\begin{aligned} 0 = {} & +15.9 + 0.6(7) - 2.4(8) + 1.8(9) + 2.2(10) - 4.2(11) \\ & + 2.0(12) + 0.9(13) - 2.4(14) + 1.5(15) + 1.1(16) - 1.9(17) \\ & + 0.8(18) + 1.6(19) - 2.3(20) + 0.7(21) + 1.1(22) - 1.8(23) \\ & + 0.7(24) \end{aligned}$$

The line North Fork to Laussedat was fixed by the previous adjustment of figure 2, and so the directions 10 and 15 must receive no further correction in the adjustment of figure 3. This is equivalent to putting (10)=0 and (15)=0 in the present adjustment and then solving the nine condition equations with the condition that the sum of the squares of all the corrections involved shall be a minimum. When proceeding to the adjustment of the next figure the line Bonney to Cornice will be considered as fixed by the present adjustment. In this way the adjustment of each figure will harmonize with the preceding adjustments, and a fair approximation to the ideal adjustment is obtained.

The condition equations are, therefore:

1. $0 = -2\cdot3 + (1) - (6) - (8) + (9) - (22) + (23)$
2. $0 = +4\cdot2 - (1) + (2) - (7) + (8) - (11) + (12)$
3. $0 = +6\cdot5 - (2) + (3) + (11) - (14)$
4. $0 = -7\cdot1 - (3) + (4) - (13) + (14) - (17) + (18)$
5. $0 = -3\cdot1 - (4) + (5) - (16) + (17) - (20) + (21)$
6. $0 = +1\cdot0 - (5) + (6) - (19) + (20) - (23) + (24)$
7. $0 = +0\cdot4 - (16) - (19) + (21) + (24) + (25) - (26)$
8. $0 = +11\cdot8 + 2\cdot0\,(4) - 3\cdot4\,(5) + 1\cdot4\,(6) + 2\cdot7\,(16) + 1\cdot1\,(17) + 0\cdot7\,(23) + 3\cdot5\,(24) - 3\cdot8\,(25) - 4\cdot2\,(26)$
9. $0 = +15\cdot9 + 0\cdot6\,(7) - 2\cdot4\,(8) + 1\cdot8\,(9) - 4\cdot2\,(11) + 2\cdot0\,(12) + 0\cdot9\,(13) - 2\cdot4\,(14) + 1\cdot1\,(16) - 1\cdot9\,(17) + 0\cdot8\,(18) + 1\cdot6\,(19) - 2\cdot3\,(20) \quad 7\,(21) + 1\cdot1\,(22) - 1\cdot8\,(23) + 0\cdot7\,(24)$

The corrections in terms of the correlates and the normal equation given in the two following tables:

THE CORRELATE EQUATIONS.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
(1) =	+1	−1						
(2) =		+1	−1					
(3) =			+1	−1				
(4) =				+1	−1			
(5) =					+1	−1		+2·0
(6) =	−1					+1		−3·4
(7) =		−1						+1·4
(8) =	−1	+1						
(9) =	+1							
(10) =								
(11) =		−1	+1					
(12) =		+1						
(13) =								
(14) =				−1				
(15) =			−1	+1				
(16) =								
(17) =					−1		−1	+2·7
(18) =				−1	+1			+1·1
(19) =				+1				
(20) =						−1	−1	
(21) =					−1	+1		
(22) =	−1				+1		+1	
(23) =	+1							
(24) =						−1		+0·7
(25) =						+1	+1	+3·5
(26) =							+1	−3·8
							−1	−4·2

THE NORMAL EQUATIONS.

		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C
0 =	−2·3	+6	−2							
0 =	+4·2	−2	+6	−2			−2		−0·7	+
0 =	+6·5		−2	+4	−2					+
0 =	−7·1			−2	+6	−2			+0·9	−
0 =	−3·1				−2	+6	−2	+2	−7·0	
0 =	+1·0	−2				−2	+6	+2	+7·6	−
0 =	+0·4					+2	+2	+6	+1·2	−
0 =	+11·8	−0·7			+0·9	−7·0	+7·6	+1 2	+70·84	+2
0 =	+15·9	+1·3	+3·2	−1·8	−0·6		−1·4	−1·3	+2·07	+56

The solution of the normal equations gives:

$C_1 = + 0{\cdot}276$
$C_2 = - 1{\cdot}065$
$C_3 = - 1{\cdot}806$
$C_4 = + 0{\cdot}949$
$C_5 = + 1{\cdot}137$
$C_6 = + 0{\cdot}606$
$C_7 = - 0{\cdot}684$
$C_8 = - 0{\cdot}109$
$C_9 = - 0{\cdot}273$

These values substituted in the correlate equations give for the most probable values of the different directions:

	"		"
(1)	= + 1·34	(14)	= + 3·41
(2)	= + 0·74	(15)	= 0·00
(3)	= − 2·75	(16)	= − 1·05
(4)	= − 0·40	(17)	= + 0·59
(5)	= + 0·90	(18)	= + 0·73
(6)	= + 0·18	(19)	= − 0·36
(7)	= + 0·90	(20)	= + 0·10
(8)	= − 0·69	(21)	= + 0·26
(9)	= − 0·21	(22)	= − 0·58
(10)	= 0·00	(23)	= + 0·09
(11)	= + 0·40	(24)	= − 0·65
(12)	= − 1·61	(25)	= − 0·27
(13)	= − 1·20	(26)	= + 1·15

When these corrections are applied to the directions, every triangle closes and the values of the sides are accordant to the seventh place of decimals.

Each of the seven figures shown was adjusted in this manner and the sides calculated from the Kootenay base at the eastern end of the net. When the measured length of the Salmon Arm base was received from Mr. Bridgland, it was found to exceed the length as computed from the Kootenay base by 0·148 metres (about six inches), or 79 in the last places of seven figure logarithms.

A further small correction to the angles was needed in order that the computed length of the Salmon Arm base should be in accordance with the measured length. This was effected by considering only the angles opposite base sides and continuation sides in any selected chain of triangles between the two bases.

Let s denote the sum of the changes in the log sines of these angles due to a change of 1″ in each angle and let l denote the logarithmic deficit or excess of the computed over the measured value of the terminal base. Then $\pm\frac{l}{s}''$ was adopted as a constant correction to each angle, applied in the present case with the positive sign to angles opposite sides of continuation, and with the negative sign to angles opposite bases in the selected chain of triangles between the two bases. In the present case, the shortest chain of triangles between the two bases having been selected, s was found to be 631 and with $l = 79$, $\frac{l}{s} = 0''\cdot13$ applied with the correct sign.

Thus the third angle of each triangle was not changed and the geometrical conditions of the triangles not violated. Having thus adjusted several triangles in each figure, small adjustments were made to the other triangles of each figure so as to minimize the lack of adjustment thus introduced.

For the figure under consideration, the corrections to the angles of the ent triangles are given in the following list, the corrections as given by the Square adjustment being given in the first column and the small seco corrections in the second column.

	1st Corr.	2nd Corr.	Total.
	"	"	"
Beavermouth	−3·49	−0·13	−3·62
Laussedat	+0·40	+0·13	+0·53
North Fork	−3·41		−3·41
Beavermouth	−0·60		−0·60
Blackwater	−1·59	−0·13	−1·72
Laussedat	−2·01	+0·13	−1·88
Beavermouth	+1·16		+1·16
Cherub	+0·67	−0·13	+0·54
Blackwater	+0·48	+0·13	+0·61
Beavermouth	−0·72		−0·72
Cornice	+0·46	−0·13	+0·33
Cherub	−0·74	+0·13	−0·61
Beavermouth	+1·30	+0·13	+1·43
Bonney	+1·64		+1·64
Cornice	+0·16	−0·13	+0·03
Beavermouth	+2·35		+2·35
North Fork	+4·61	+0·13	+4·74
Bonney	+0·14	−0·13	+0·01
Beavermouth	+0·58	+0·13	+0·71
Cherub	+1·06		+1·06
Bonney	+0·86	−0·13	+0·73
Cherub	−1·80	+0·13	−1·67
Bonney	+0·78	+0·13	+0·91
Cornice	+0·62	−0·26	+0·36

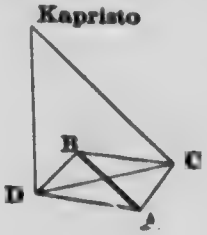
Signal at Bastion station.

Cairn at North Fork station.

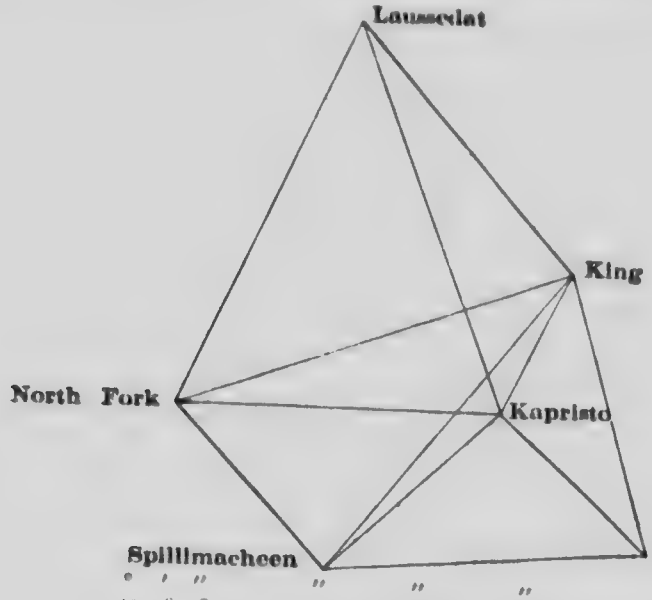
Following are the full computations for the calculation of the triangles of the main net of the triangulation:—

ADJUSTED TRIANGLES OF MAIN NET—BRITISH COLUMBIA TRIANGULATION.

Stations.	Observed Angles.	Corrections.	Spherical Angles.	Spherical Excess.	Log Distance.	Distance (metres).
Figure 1						
	° ′ ″	″	″	″		
C	59 39 20	−0·49	19·51	0·04	3·9327565	8565·574
A	88 25 58	−1·36	56·64	0·04	3·9965819	9921·60
B	31 54 42	+1·97	43·97	0·04	3·7198873	5246·71
D	55 40 42	−0·44	41·56	0·04	3·9327565	8565·574
A	31 31 28	−0·08	27·92	0·04	3·7342245	5422·81
B	92 47 50	+0·64	50·64	0·04	4·0153197	10359·05
D	19 18 13	−4·61	08·39	0·04	3·7198873	5246·71
A	119 57 26	−1·48	24·52	0·04	4·1383662	13752·0
C	40 44 29	−1·79	27·21	0·04	4·0153197	10359·05
D	36 22 29	+4·21	33·21	0·04	3·9965819	9921·60
B	124 42 32	+2·57	34·57	0·04	4·1383662	13752·0
C	18 54 51	+1·34	52·34	0·04	3·7342244	5422·81
Kapristo	41 40 34	−0·93	33·07	0·20	4·1383662	13752·0
D	81 53 26	−0·67	25·33	0·20	4·3112352	20475·5
C	56 26 03	−0·80	02·20	0·20	4·2363746	17233·5

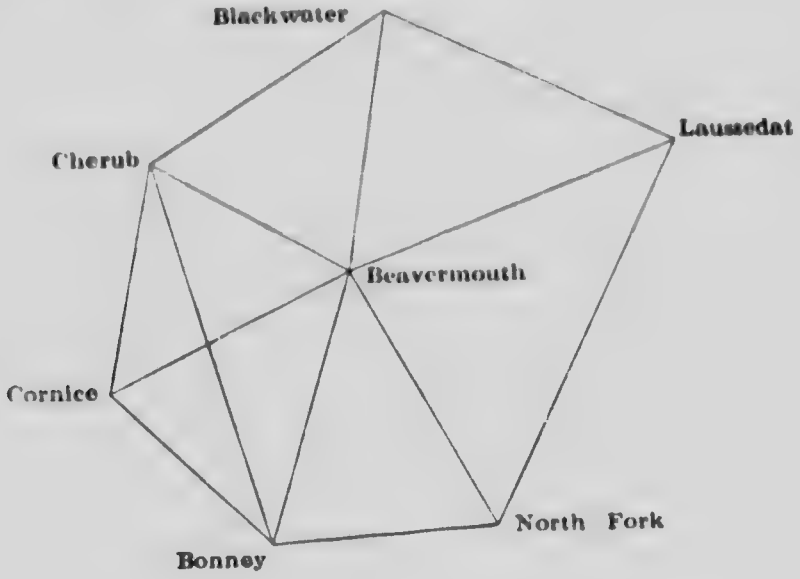


Stations.	Observed Angles.	C	Spherical Angles.	Spherical Excess.	Log Distance.	Dista (metr
Figure 2						



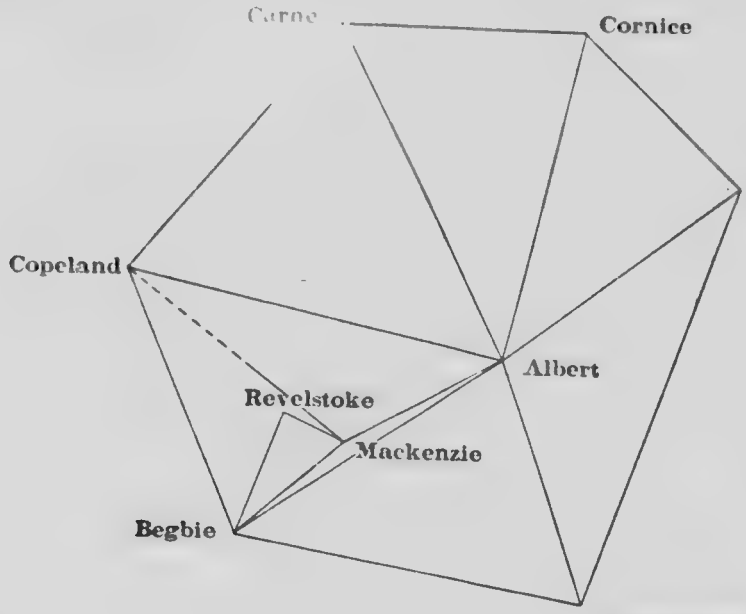
	° ′ ″	″	″	″		
King	40 53 18	+0·86	18·86	0·27	4·3112352	20475·
C	30 35 48	+1·06	49·06	0·27	4·2012513	15894·
Kapristo	108 25 52·1	+0·78	52·88	0·26	4·4716685	29625·
Laussedat	19 58 18	−1·89	16·11	0·40	4·2012513	15894·
King	114 09 25	−0·27	24·73	0·40	4·6280026	42462·
Kapristo	45 52 20·2	+0·16	20·36	0·40	4·5238000	33[illegible]
North Fork	66 18 30·3	−2·04	28·26	1·10	4·6280026	42462·
Laussedat	45 11 11	+1·97	12·97	1·10	4·5171371	32895·
Kapristo	68 30 24·1	−2·03	22·07	1·10	4·6349374	43145·
Spillimacheen	38 21 42	−0·91	41·09	0·43	4·3112352	20475·
C	48 08 00	−0·89	59·11	0·43	4·3903895	24569·
Kapristo	93 30 21·3	−0·20	21·10	0·44	4·5175972	32930·
North Fork	48 16 56·1	+3·63	59·73	0·47	4·3903895	24569·
Spillimacheen	88 01 56	+2·08	58·08	0·46	4·5171373	32895·
Kapristo	43 41 02·3	+1·29	03·59	0·47	4·3566721	22733·
Laussedat	45 11 11	+1·97	12·97	1·10	4·5171372	32895·
North Fork	66 18 30·3	−2·04	28·26	1·10	4·6280027	42462·
Kapristo	68 30 24·1	−2·03	22·07	1·10	4·6349375	43145·
Spillimacheen	46 57 04	−0·87	03·13	0·80	4·4716685	29625·
C	78 33 48	+0·17	48·17	0·80	4·5994337	39758·
King	54 19 14	−2·90	11·10	0·80	4·5175972	32930·
North Fork	68 25 56·2	+1·75	57·95	0·73	4·5994337	39758·
King	32 07 26	+2·39	28·39	0·74	4·3566720	22733·
Spillimacheen	79 26 34	+1·86	35·86	0·73	4·6235435	42028·
King	45 28 22	−1·34	20·66	0·37	4·5171371	32895·
Kapristo	114 22 44·3	−1·95	42 35	0·36	4·6235435	42028·
North Fork	20 09 00·1	−2·01	58·09	0·37	4·2012513	15894·
Laussedat	65 09 29	+0·08	29·08	1·10	4·6235435	42028·
North Fork	46 09 30·1	+0·11	30·21	1·11	4·5238001	33404·
King	68 41 03	+1·02	04·02	1·10	4·6349373	43145·

Figure 3



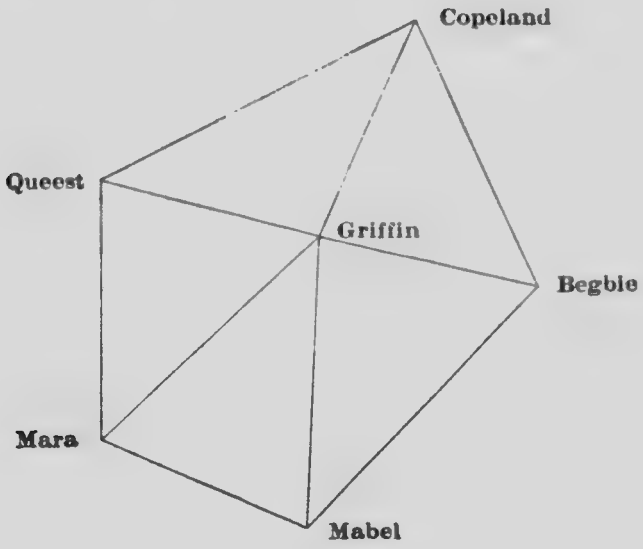
Stations.	Observed Angles.	Correc-tions.	Spher-ical Angles.	Spher-ical Excess.	Log Distance.	Distance (metres).
	° ′ ″	″	″	″		
Beavermouth	83 21 25·9	−3·62	22·28	0·86	4·6349374	43145·7
North Fork	53 31 53·2	−3·41	49·79	0·87	4·5432123	34931·1
Laussedat	43 06 50	+0·53	50·53	0·87	4·4725704	29687·3
Blackwater	73 02 54·3	−1·72	52·58	0·67	4·5432123	34931·1
Beavermouth	60 56 01·9	−0·60	01·30	0·67	4·5040450	31918·7
Laussedat	46 01 10	−1·88	08·12	0·66	4·4195767	26277·1
Cherub	61 32 42	+0·54	42·54	0·47	4·4195767	26277·1
Beavermouth	68 21 46·8	+1·16	47·96	0·47	4·4437611	27781·8
Blackwater	50 05 30·3	+0·61	30·91	0·47	4·3603299	22926·1
Cornice	52 38 19·5	+0·33	19·83	0·43	4·3603299	22926·1
Beavermouth	56 32 15·8	−0·73	15·08	0·43	4·3813526	24063·2
Cherub	70 49 27	−0·61	26·39	0·44	4·4352666	27243·7
Bonney	62 34 05	+1·64	06·64	0·47	4·4352666	27243·7
Beavermouth	45 51 02·3	+1·43	03·73	0·46	4·3429081	22024·6
Cornice	71 34 51	+0·03	51·03	0·47	4·4642290	29122·5
Bonney	68 51 02	+0·01	02·01	0·50	4·4725704	29687·3
Beavermouth	44 57 27·3	+2·35	29·65	0·50	4·3520227	22491·7
North Fork	66 11 25·1	+4·74	29·84	0·50	4·4642291	29122·5
Bonney	33 20 13	+0·73	13·73	0·53	4·3603299	22926·1
Beavermouth	102 23 18·1	+0·71	18·81	0·54	4·6100811	40745·6
Cherub	44 16 28	+1·06	29·06	0·53	4·4642292	29122·5
Cornice	124 13 10·5	+0·36	10·86	0·36	4·6100811	40745·6
Cherub	26 32 59	−1·67	57·33	0·37	4·3429081	22024·6
Bonney	29 13 52	+0·91	52·91	0·37	4·3813528	24063·2

Stations.	Observed Angles.	Correc-tions.	Spher-ical Angles.	Spher-ical Excess.	Log Distance.	Dis (me
Figure 4						

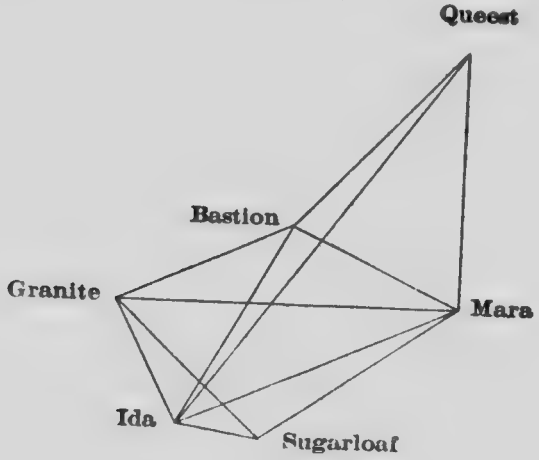


	° ′ ″	″	″	″		
Albert						
Bonney	40 26 19·18	−0·91	18·27	0·53	4·3429081	22024
Cornice	80 21 07·33	+0·89	08·22	0·54	4·5247259	33475
	59 12 35·89	−0·78	35·11	0·53	4·4649285	29169
Carnes						
Albert	62 31 05·63	−0·40	05·23	0·66	4·5247259	33475
Cornice	39 14 33·71	+1·31	35·02	0·66	4·3778616	23870
	78 14 20·90	+0·83	21·73	0·66	4·5675120	36941
Copeland						
Albert	60 55 09·28	−3·67	05·61	0·95	4·5675120	36941
Carnes	51 00 00·42	−1·75	58·67	0·95	4·5165367	32850
	68 04 59·94	−1·37	58·57	0·95	4·5934565	39215
Begbie						
Albert	79 21 10·87	−3·55	07·32	0·77	4·5934565	39215
Copeland	46 35 12·88	−0·64	12·24	0·78	4·4621837	28985
	54 03 41·48	+1·30	42·78	0·78	4·5092970	32307
Incomappleux						
Albert	38 19 03·23	+2·81	06·04	0·60	4·4649285	29169
Bonney	108 20 12·83	+0·62	13·45	0·61	4·6498855	44656
	33 20 43·94	−1·62	42·32	0·60	4·4126255	25860
Begbie						
Albert	44 29 34·81	+3·56	38·37	0·68	4·4126255	25860
Incomappleux	74 23 40·98	+1·50	42·48	0·68	4·5507004	35538
	61 06 42·75	−1·56	41·19	0·68	4·5092971	32307
Copeland						
Albert	54 03 41·48	+1·30	42·78	0·78	4·5092971	32307
Begbie	46 35 12·88	−0·64	12·24	0·78	4·4621838	28985
	79 21 10·87	−3·55	07·32	0·77	4·5934566	39215
Mackenzie						
Copeland	74 12 29·42	+2·16	31·58	0·35	4·4621838	28985
Begbie				0·34	4·1646262	14609
	76 46 46·17	−0·03	46·14	0·35	4·4672262	29324
Mackenzie						
Copeland	110 29 00·98	+1·14	02·12	0·41	4·5934566	39215
Albert				0·41	4·2485789	17724
	44 27 56·61	+3·05	59·66	0·41	4·4672260	29324
Revelstoke						
Begbie	81 20 32·96	+2·04	35·00	0·09	4·1646262	14609
Mackenzie	32 35 08·37	+2·13	10·50	0·09	3·9008432	7958
	66 04 11·60	+3·18	14·78	0·08	4·1305699	13507

Stations.	Observed Angles.	Correc-tions.	Spher-ical Angles.	Spher-ical Excess.	Log Distance.	Distance (metres).
Figure 5.						
	° ′ ″	″	″	″		
Griffin	78 39 29·14	−2·08	27·06	0·43	4·4621838	28985·7
Begbie	52 35 19·73	−5·41	14 32	0·43	4·3707231	23481·3
Copeland	48 45 16·24	+3·67	19·91	0·43	4·3469114	22228·6
Queest	41 39 00·13	+2·51	02·64	0·44	4·3707231	23481·3
Griffin	98 49 30·39	−1·12	29·27	0·44	4·5430000	34914·0
Copeland	39 31 34·18	−4·76	29·42	0·44	4·3519093	22485·8
Mara	47 18 24·88	+3·17	28·05	0·47	4·3519093	22485·8
Griffin	57 09 42·26	+3·01	45·27	0·47	4·4100073	25704·4
Queest	75 31 48·69	−0·59	48·10	0·48	4·4716189	29622·3
Mabel	40 36 39·02	−4·78	34·24	0·54	4·3469114	22228·6
Griffin	80 28 24·10	+0·82	24·92	0·55	4·5273673	33679·6
Begbie	58 54 57·07	+5·40	02·47	0·54	4·4660862	29247·3
Mara	66 40 36·49	−3·29	33·20	0·52	4·4660862	29247·3
Griffin	44 52 54·11	−0·62	53·49	0·51	4·3516956	22474·8
Mabel	68 26 29·98	+4·89	34·87	0·52	4·4716187	29622·3

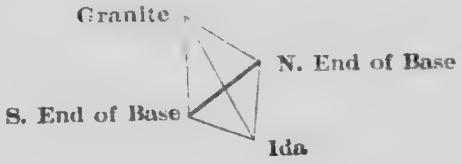


Stations.	Observed Angles.	Correc-tions.	Spher-ical Angles.	Spher-ical Excess.	Log Distance.	Dis (me
Figure 6.						



	° ′ ″	″	″	″		
Bastion						
Queest	70 25 36·07	+1·12	37·19	0·37	4·4100072	25704·
Mara	43 45 31·24	+0·03	31·27	0·37	4·2757256	18868·
	65 48 52·62	+0·03	52·65	0·37	4·3959587	24886·
Ida						
Mara	38 02 52·17	−1·77	50·40	0·37	4·2757256	18868·
Bastion	48 49 43·78	+1·22	45·00	0·37	4·3625761	23045·
	93 07 28·28	−2·60	25·68	0·38	4·4852801	30568·
Ida						
Queest	29 30 19·86	−3·44	16·42	0·60	4·4100072	25704·
Mara	35 51 05·85	+2·03	07·88	0·61	4·4852801	30568·
	114 38 36·40	+1·12	37·52	0·61	4·6761348	47438·
Granite						
Ida	86 47 58·91	+0·91	59·82	0·23	4·3625761	23045·0
Bastion	56 35 42·87	−0·07	42·80	0·22	4·2848369	19268·0
	36 36 13·99	+4·07	18·06	0·22	4·1387145	13763·0
Granite						
Mara	24 51 13·33	+0·09	13·42	0·24	4·2757256	18868·0
Bastion	25 25 03·39	+0·17	03·56	0·24	4·2848364	19268·0
	129 43 42·27	+1·47	43·74	0·23	4·5381350	34525·1
Ida						
Granite	94 38 35·04	−1·84	33·20	0·36	4·5381350	34525·1
Mara	61 56 45·58	+0·82	46·40	0·35	4·4852798	30568·9
	23 24 40·39	+1·05	41·44	0·35	4·1387143	13763·04
Sugarloaf						
Granite	104 01 36·11	+2·66	38·77	0·39	4·5381350	34525·1
Mara	42 08 45·94	+0·91	46·85	0·39	4·3780215	23879·3
	33 49 35·38	+0·17	35·55	0·39	4·2968874	19810·1
Ida						
Granite	126 00 10·54	+0·63	11·17	0·07	4·2968874	19810·1
Sugarloaf	19 47 59·64	+0·05	59·69	0·08	3·9188082	8294·84
	34 11 50·89	−1·52	49·37	0·08	4·1387143	13763·04
Sugarloaf						
Ida	138 13 27·00	+1·31	28·31	0·12	4·4852800	30568·9
Mara	31 21 35·50	+2·46	37·96	0·11	4·3780216	23879·3
	10 24 54·99	−0·96	54·03	0·11	3·9188082	8294·84

Stations.	Observed Angles.	Correc-tions.	Spher-ical Angles.	Spher-ical Excess.	Log Distance.	Distance (metres).
Figure 7.						
	° ′ ″	″	″	″		
North end	119 30 31·91	−0·01	31·90	0·04	4·1387144	13763·04
Granite	28 22 31·34	−1·17	30·17	0·05	3·8759695	7515·70
Ida	32 06 54·80	+3·30	58·10	0·05	3·9246708	8407·58
South end	55 06 58·71	−3·72	54·99	0·06	3·9246708	8407·58
Granite	52 53 59·56	−1·41	58·15	0·06	3·9124693	8174·652
North end	71 59 08·53	−1·44	07·09	0·05	3·9888661	9746·89
South end	115 54 17·86	−1·89	15·97	0·05	4·1387144	13763·04
Granite	24 31 28·22	−0·24	27·98	0·04	3·8028346	6350·89
Ida	39 34 18·44	−2·22	16·22	0·04	3·9888657	9746·88
North end	47 31 23·38	+1·43	24·81	0·04	3·8028346	6350·89
Ida	71 41 13·24	+1·08	14·32	0·03	3·9124693	8174·652
South end	60 47 19·15	+1·83	20·98	0·04	3·8759697	7515·70



GEODETIC POSITIONS.

Azimuth observations were taken at several stations of the triangulation, the average range of the observations at each station being about 18″. For the purpose of calculating the geodetic positions, a mean azimuth was obtained by reducing the azimuth observations at the five stations Mara, Queest, Griffin, Mabel, and South End to the station Mara. They were reduced by accepting an approximate azimuth and calculating the convergence over each line by the formulæ mentioned below. When reduced to Mara, these azimuths gave for the azimuth of the line Mara to Queest, the following values:—

Observation at	Reduced Azimuth Mara to Queest.		
	°	′	″
Mara	1	15	14·9
Queest	1	15	14·9
Griffin	1	15	20·4
Mabel	1	14	54·9
South End	1	15	29·8

The mean azimuth accepted for the line Mara to Queest was 1° 15′ 15″. The observed azimuth at Albert differed by 2″, and that at Incomappleux by 8″ from the azimuths as computed through the triangulation from Mara.

The latitudes and longitudes were calculated by the formulæ and con
used by the United States Coast and Geodetic Surveys, a full account of w
may be found in the United States Coast and Geodetic Surveys Report,
II, 1894.

The formulæ for the computation of the geodetic differences in lati
(dL), in longitude (dM), and in azimuth (dZ), for two stations of latitu
and L′, longitude M and M′, and azimuth of the line at each station Z an
+ 180° are:

$$-dL = -B.K \cos Z + C.K^2 \sin^2 Z + D.h^2 - E.hK^2 \sin^2 Z$$
$$dM = -A.K \sin Z \sec L'$$
$$-dZ = dM \sin \tfrac{1}{2}(L+L') \sec \tfrac{1}{2} dL$$

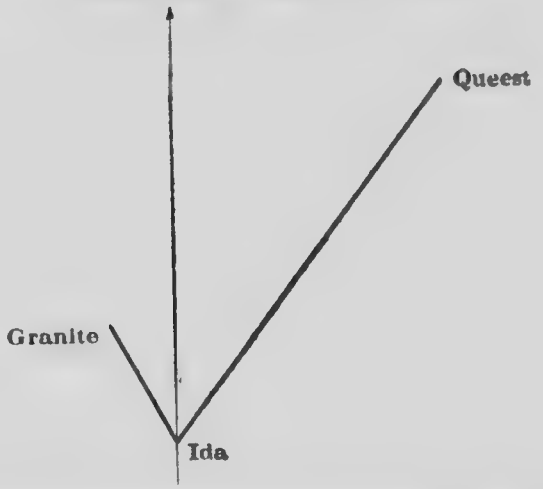
where $h = -B.K \cos Z$

and A, B, C, D and E are constants. The logarithms of these constants, ba
upon the Clarke Spheroid of 1866 are tabulated in Part II of the United St
Coast and Geodetic Survey Report for 1894.

A specimen sheet is given, showing the differences of latitude, longitu
and azimuth over the line Ida to Queest.

TRIANGULATION OF B.C. RAILWAY BELT

POSITION COMPUTATION



						°	′	″
Z	At	Ida	to Granite			331	39	39·2
Angle		Granite	to Queest			65	08	16·8
Z	At	Ida	to Queest			36	47	56·0
d Z						+ 180	18	49·2
Z′	At	Queest	to Ida			217	06	45·2

		°	′	″		°	′	″
Ida	L	50	38	45·68	M	119	16	41·34
	d L	+	20	26·76	d M	−	24	16·83
Queest	L′	50	59	12·44	M′	118	52	24·51

K = 47438·9 m.

−K	4·6761348n	K²	9·35227	h²		−h	3·0897
cos Z	1·9034931	sin²Z	1·55486	D	6·1793	K²sin²Z	8·9071
B	2·5100344	C	9·48957		8·3844	E	14·3479
	3·0896623n		0·39670		2·5637		2·3447
	″						
1st term	−1229·318	3rd term	+0·037				
2nd "	+ 2·494	4th "	+0·022				
	−1226·824		+0·059				
3rd & 4th term	+ ·059						
− d L	−1226·765					d M	3·16341n
	° ′ ″	− K	4·6761348n	Arg.		sin½(L+L′)	1·88937
		sin Z	1·7774327	K	− 41		0·0
½(L+L′)	50 48 59·06	A	2·5088374			sec ½ d L	
½ d L	10 13·38	sec L′	0·2010045	d M	+ 37		3·05278n
			3·1634090	Corn	− 04		
			−4			− d Z	−1129·2
			3·1634086n				
		d M	−1456″·831				

GEODETIC POSITIONS.

Main Net of British Columbia Triangulation.

Station.	Latitude.	Longitude.	Azimuth.	Back Azimuth.	To Station.	Distance.	Logarithm.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		Metres.	
A	51 02 43·38	116 35 25·98	277 40 32	97 33 42	D	10359·05	4·0153198
			309 12 00	129 07 35	B	8565·574	3·9327565
			37 37 57	217 40 05	C	5246·71	3·7198873
B	51 05 38·42	116 41 07·07	97 12 51	277 19 24	C	9921·60	3·9965819
			129 07 35	309 12 00	A	8565·574	3·9327565
			221 55 25	41 53 01	D	5422·81	3·7342245
C	51 04 57·80	116 32 41·40	217 40 05	37 37 57	A	5246·71	3·7198873
			258 24 32	78 15 34	D	13752·0	4·1383662
			266 42 35	86 20 42	Spillimacheen	32930·4	4·5175972
			277 19 24	97 12 51	B	9921·60	3·9965819
			314 50 34	134 40 52	Kapristo	20475·5	4·3112352
			345 26 23	165 21 23	King	29625·7	4·4716685
D	51 03 27·82	116 44 13·11	356 22 09	176 21 25	Kapristo	17233·5	4·2363746
			41 53 01	221 55 25	B	5422·81	3·7342245
			78 15 34	258 24 32	C	13752·0	4·1383662
			97 33 42	277 40 32	A	10359·05	4·0153198
King	51 20 25·49	116 39 06·16	165 21 23	345 26 23	C	29625·7	4·4716685
			206 19 42	26 14 59	Kapristo	15894·7	4·2012513
			219 40 34	39 23 38	Spillimacheen	39758·8	4·5994337
			251 48 03	71 21 17	North Fork	42028·5	4·6235435
			320 29 07	140 14 44	Laussedat	33404·1	4·5238000
Kapristo	51 12 44·36	116 45 09·33	26 14 59	206 19 42	King	15894·7	4·2012513
			134 40 52	314 50 34	C	20475·5	4·3112352
			176 21 25	356 22 09	D	17233·5	4·2363746
			238 11 13				

Kapristo	51	12	44·36	116	45	09·33	26	14	59	206	19	42	King	33404·1	4·5238000
							134	40	52	314	50	34	C	15894·7	4·2012513
							176	21	25	356	22	09	D	20475·5	4·3112352
							228	11	13	47	59	01	Spillimacheen	17233·5	4·2363746
							271	52	16	91	30	16	North Fork	24569·1	4·3903895
							340	22	39	160	13	00	Laussedat	32895·6	4·5171372
														42462·2	4·6280026

Laussedat	51	34	17·90	116	57	29·74	140	14	44	320	29	07	King	33404·1	4·5238000
							160	13	00	340	22	39	Kapristo	42462·2	4·6280026
							205	24	13	25	11	47	North Fork	43145·7	4·6349374
							248	31	03	68	09	06	Beavermouth	34931·1	4·5432123
							294	32	11	114	12	26	Blackwater	31918·7	4·5040450
Spillimacheen	51	03	53·25	117	00	49·72	319	57	02	139	47	15	North Fork	22733·8	4·3566720
							39	23	38	219	40	34	King	39758·8	4·5994337
							47	59	01	228	11	13	Kapristo	24569·1	4·3903895
							86	20	42	266	42	35	C	32930·4	4·5175972
North Fork	51	13	15·71	117	13	23·46	265	28	28	85	13	27	Bonney	22491·7	4·3520227
							331	39	57	151	30	28	Beavermouth	29687·3	4·4725704
							25	11	47	205	24	13	Laussedat	43145·7	4·6349374
							71	21	17	251	48	03	King	42028·5	4·6235435
							91	30	16	271	52	16	Kapristo	32895·6	4·5171372
							139	47	15	319	57	02	Spillimacheen	22733·8	4·3566720
Blackwater	51	41	24·09	117	22	41·32	114	12	26	294	32	11	Laussedat	31918·7	4·5040450
							187	15	19	7	13	04	Beavermouth	26277·1	4·4195767
							237	20	50	57	05	00	Cherub	27781·8	4·4437611
Beavermouth	51	27	20·62	117	25	33·19	7	13	04	187	15	19	Blackwater	26277·1	4·4195767
							68	09	06	248	31	03	Laussedat	34931·1	4·5432123
							151	30	28	331	39	58	North Fork	29687·3	4·4725704
							196	27	57	16	22	25	Bonney	29122·5	4·4642291
							242	19	01	62	02	47	Cornice	27243·7	4·4352666
							298	51	16	118	37	40	Cherub	22926·1	4·3603299
Bonney	51	12	16·70	117	32	38·38	16	22	25	196	27	57	Beavermouth	29122·5	4·4642291
							85	13	27	265	28	28	North Fork	22491·7	4·3520227
							200	06	28	19	56	18	Incomappleux	44656·6	4·6498855
							233	27	11	53	11	34	Albert	29169·5	4·4649285
							313	48	19	133	37	38	Cornice	22024·6	4·3429081
							343	02	12	162	54	10	Cherub	40745·6	4·6100811
Cherub	51	33	17·33	117	42	55·40	57	04	58	237	20	50	Blackwater	27781·8	4·4437611
							118	37	40	298	51	16	Beavermouth	22926·1	4·3603299
							162	54	10	343	02	12	Bonney	40745·6	4·6100811
							189	27	07	9	24	27	Cornice	24063·2	4·3813527
Incomappleux	50	49	38·96	117	45	42·78	280	30	31	100	07	25	Begbie	35538·6	4·5507004
							303	11	45	122	56	22	Mackenzie	27733·0	4·4429967
							341	37	12	161	31	47	Albert	25860·2	4·4126255
							19	56	19	200	06	28	Bonney	44656·6	4·6498855

GEODETIC POSITIONS—*Continued.*

Station.	Latitude.	Longitude.	Azimuth.	Back Azimuth.	To Station.	Distance.	Logarithm.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		Metres.	
Cornice	51 20 29·22	117 46 19·55	9 24 27	189 27 07	Cherub	24063·2	4·3813527
			62 02 47	242 19 01	Beavermouth	27243·7	4·4352666
			133 37 38	313 48 19	Bonney	22024·6	4·3429081
			192 50 13	12 45 16	Albert	33475·4	4·5247259
			271 04 35	90 48 32	Carnes	23870·5	4·3778616
Albert	51 02 52·90	117 52 41·36	12 45 16	192 50 13	Cornice	33475·4	4·5247259
			53 11 34	233 27 11	Bonney	29169·5	4·4649285
			161 31 47	341 37 12	Incomappleux	25860·2	4·4126255
			235 55 30	55 37 46	Begbie	32307·0	4·5092971
			238 02 44	57 52 45	Mackenzie	17724·7	4·2485789
			282 30 42	102 05 10	Copeland	39215·4	4·5934566
			333 30 41	153 19 37	Carnes	36941·3	4·5675120
Carnes	51 20 41·93	118 06 52·64	90 48 32	271 04 35	Cornice	23870·5	4·3778616
			153 19 37	333 30 41	Albert	36941·3	4·5675120
			221 24 36	41 10 05	Copeland	32850·1	4·5165367
Revelstoke	50 59 54·34	118 11 28·05	119 10 49	299 15 26	Mackenzie	7958·7	3·9008432
			200 31 23	20 28 15	Begbie	13507·3	4·1305699
Mackenzie	50 57 48·62	118 05 31·99	57 52 45	238 02 44	Albert	17724·7	4·2485789
			122 56 22	303 11 45	Incomappleux	27733·0	4·4429967
			233 11 11	53 03 26	Begbie	14609·2	4·1646262
			299 15 26	119 10 49	Revelstoke	7958·7	3·9008432
			307 23 43	127 08 10	Copeland	29324·2	4·4672261
Begbie	50 53 04·91	118 15 30·29	224 46 22	44 30 47	Mabel	33679·6	4·5273673
			283 41 25	103 27 06	Griffin	22228·6	4·3469114
			336 16 39	156 08 53	Copeland	28985·7	4·4621838
			20 28 15	200 31 23	Revelstoke	13507·3	4·1305699
			53 03 26	233 11 11	Mackenzie		

							283	41	25	103	27	06	Griffin	22228·6	4·3469114
							336	16	39	156	08	53	Copeland	28985·7	4·4621838
							20	28	15	200	31	23	Revelstoke	13507·3	4·1305699
							53	03	26	233	11	11	Mackenzie	14609·2	4·1646262
							55	37	46	235	55	30	Albert	32307·0	4·5092971
							100	07	25	280	30	31	Incomappleux	35538·6	4·5507004
	Copeland	51	07	23·21	118	25	29·88	41	10	05	221	24	36	Carnes	32850·1	4·5165367
								102	05	10	282	30	42	Albert	39215·4	4·5934566
								127	08	10	307	23	43	Mackenzie	29324·2	4·4672261
								156	08	53	336	16	39	Begbie	28985·7	4·4621838
								204	54	13	24	47	39	Griffin	234[illegible]3	4·3707231
								224	25	42	64	04	47	Queest	34914·0	4·5430000
	Griffin	50	55	53·70	118	33	56·20	24	47	39	204	54	13	Copeland	23481·3	4·3707231
								103	27	06	283	41	25	Begbie	22228·6	4·3469114
								183	55	31	3	54	12	Mabel	29247·3	4·4660862
								228	48	25	48	33	43	Mara	29622·3	4·4716188
								285	58	10	105	43	49	Queest	22485·8	4·3519093
	Mabel	50	40	09·43	118	35	38·15	295	27	38	115	14	16	Mara	22474·8	4·3516956
								3	54	12	183	55	31	Griffin	29247·3	4·4660862
								44	30	47	224	46	22	Begbie	33679·6	4·5273673
	Queest	50	59	12·44	118	52	24·51	64	04	47	224	25	42	Copeland	34914·0	4·5430000
								105	43	49	285	58	10	Griffin	22485·8	4·3519093
								181	15	37	1	15	15	Mara	25704·4	4·4100072
								217	06	45	36	47	56	Ida	47438·9	4·6761348
								225	01	09	44	49	31	Bastion	24886·2	4·3959587
	Mara	50	45	20·83	118	52	53·35	236	11	43	55	58	42	Sugarloaf	23879·3	4·3780216
								246	36	37	66	18	12	Ida	30568·9	4·4852800
								270	01	19	89	38	35	Granite	34525·1	4·5381350
								295	26	22	115	15	08	Bastion	18868·0	4·2757256
								1	15	15	181	15	37	Queest	25704·4	4·4100072
								48	33	43	228	48	25	Griffin	29622·3	4·4716188
								115	14	16	295	27	38	Mabel	22474·8	4·3516956
	Bastion	50	49	42·22	119	07	23·92	44	49	31	225	01	09	Queest	24886·2	4·3959587
								115	15	08	295	26	22	Mara	18868·0	4·2757256
								208	22	34	28	15	22	Ida	23045·0	4·3625761
								244	58	52	64	47	21	Granite	19268·0	4·2848367
	Sugarloaf	50	38	09·67	119	09	43·03	277	45	14	97	39	51	Ida	8294·84	3·9188082
								311	57	03	131	47	22	Granite	19810·1	4·2968874
								55	58	42	236	11	43	Mara	23879·3	4·3780216

GEODETIC POSITIONS—*Continued.*

Station.	Latitude.			Longitude.			Azimuth.			Back Azimuth.			To Station.	Distance.	Logarithm.
	°	′	″	°	′	″	°	′	″	°	′	″		Metres.	
Ida	50	38	45·68	119	16	41·34	292	05	23	112	01	31	S. End	6350·89	3·8028346
							331	39	39	151	35	21	Granite	13763·04	4·1387144
							3	46	37	183	46	57	N. End	7515·70	3·8759696
							28	15	22	208	22	34	Bastion	23045·0	4·3625761
							36	47	56	217	06	45	Queest	47438·9	4·6761348
							66	18	12	246	36	37	Mara	30568·9	4·4852800
							97	39	51	277	45	14	Sugarloaf	8294·84	3·9188082
Granite	50	45	17·56	119	22	14·62	64	47	1	244	58	52	Bastion	19268·0	4·2848367
							89	38	35	270	01	19	Mara	34525·1	4·5381350
							123	12	51	303	17	29	N. End	8407·58	3·9246708
							131	47	22	311	57	03	Sugarloaf	19810·1	4·2968874
							151	35	21	331	39	39	Ida	13763·04	4·1387144
							176	06	49	356	07	15	S. End	9746·89	3·9888659
N. End Base	50	42	48·37	119	16	16·11	183	46	57	3	46	37	Ida	7515·70	3·8759696
							231	18	22	51	14	10	S. End	8174·652	3·9124693
							303	17	29	123	12	51	Granite	8407·58	3·9246708
End Base	50	40	02·86	119	21	40·98	356	07	15	176	06	49	Granite	9746·89	3·9888659
							51	14	10	231	18	22	N. End	8174·652	3·9124693
							112	01	31	292	05	23	Ida	6350·89	3·8028346

Mount Begbie

Cairn at Begbie station.

SECONDARY STATIONS—BRITISH COLUMBIA TRIANGULATION.

Station.	Latitude.	Longitude.	Azimuth.	Back Azimuth.	To Station.	Distance.	Logarithm.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		Metres.	
Beaverfoot	51 04 28·55	116 31 12·48	268 23 15	88 00 08	Spillimacheen	35428·2	4·5493490
			297 34 57	117 33 48	C	19527·6	4·2906479
			342 46 42	162 40 33	King	30969·6	4·4909362
			67 21 55	247 45 49	Storm	38815·2	4·5890015
Storm	51 12 27·90	116 00 26·98	247 45 49	67 21 55	Beaverfoot	38815·2	4·5890015
			288 25 32	107 55 24	King	47317·6	4·6750230
			249 54 35	69 29 27	C	40093·5	4·6030736
McArthur	51 32 25·53	116 36 00·00	189 11 58	9 09 32	King	22541·2	4·3529776
			278 05 48	97 48 58	Laussedat	25089·8	4·3994973
			321 01 20	140 52 52	Blaeberry	19780·7	4·2962424
Blaeberry	51 40 42·59	116 46 47·56	140 52 52	321 01 20	McArthur	19780·7	4·2962424
			166 38 25	346 44 26	King	38652·8	4·5871808
			226 10 03	46 01 40	Laussedat	17145·3	4·2341452
Yellow	51 50 49·65	117 15 44·69	145 26 00	325 40 20	Laussedat	37168·3	4·570173*
			204 36 37	24 31 10	Blackwater	19219·0	4·2837308
			240 31 49	60 27 47	Val	6763·9	3·8301946
			262 25 36	82 10 22	Bush	22480·2	4·3517994
Val	51 49 01·9	117 20 52·1	60 27·8	240 31·8	Yellow	6763·9	3·8301946
			188 26·2	8 24·8	Blackwater	14302·9	4·1554231
Bush	51 49 12·20	117 35 08·07	15 45·0	195 48·3	·entry	18063·8	4·256810
			82 10·4	262 25·6	Yellow	22480·2	4·3517994
			135 12·2	315 22·0	Blackwater	20358·8	4·3087526
			196 58·3	16 52·2	Cherub	30846·3	4·4892037

GEODETIC POSITIONS—*Continued.*

Station.	Latitude.	Longitude.	Azimuth.	Back Azimuth.	To Station.	Distance.	Logarithm.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		Metres.	
Grand	51 05 21·17	117 22 51·34	262 42·5	82 19·2	Albert	35154·	4·545975
			318 26·3	138 18·7	Bonney	17179·	4·235000
			18 58·0	199 01·6	Cecil	16672·	4·221996
			36 54·2	217 01·6	North Fork	18354·	4·263726
			95 53·1	276 10·3	Spillimacheen	25872·	4·412829
Amyot	51 04 18·42	116 56 49·92	260 34·1	80 31·0	Spillimacheen	4733·5	3·675187
			310 47·6	130 34·6	North Fork	25469·	4·406016
			34 31·8	214 45·6	King	36327·	4·560229
Byron	51 04 20·10	116 58 10·41	226 36·9	46 34·8	Post	4405·8	3·644021
			255 02·6	75 00·6	Spillimacheen	3210·9	3·506633
			313 06·1	132 54·2	N. Fork	24269·	4·385053
			36 32·8	216 47·7	King	37196·	4·570492
			44 10·3	224 20·5	Kapristo	21758·	4·337617
			87 35·6	267 55·5	C		
			89 21·0	269 42·1	Beaverfoot		
Post	51 02 42·13	117 00 54·77	2 33·8	182 33·9	Spillimacheen	2199·9	3·342401
			46 34·8	226 36·9	Byron	4405·8	3·644021
Aub	51 13 34·57	117 16 58·03	97 56·7	277 59·5	N. Fork	4204·5	3·623718
			200 35·9		Pick	2307·3	3·363110
Cecil	51 13 51·29	117 18 12·02	342 11·7	161 05·9	Beavermouth	26429·8	4·422094
			101 04·7	281 08·5	N. Fork	5706·5	3·756370
			166 51·9	346 52·3	Pick	2748·6	3·439106
			199 01·6	18 58·0	Grand		
Pick			346 52·3	166 51·9	Cecil	2748·6	3·439106
				200 35·9	Aub	2307·3	3·363110
			72 23·3	252 26·6	N. Fork	5220·4	3·717704

Pick							346	52·3	166	51·9	Cecil	2748·6	3·439106
									200	35·9	Aub	2307·3	3·363110
							72	23·3	252	26·6	N. Fork	5220·4	3·717704
Donald	51	25	40·98	117	14	38·54	283	45·7	103	37·2	Beavermouth	25788·	4·114413
							342	21·3	162	15·0	Blackwater	30596·	4·485663
Riv	51	31	26·92	117	24	40·02	187	41·4	7	40·4	Beavermouth	7680·9	3·885410
							291	36·3	111	28·5	Cupola	12330·6	4·090985
Cupola	51	33	53·40	117	34	35·20	44	30·7	224	40·0	Blackwater	19558·7	4·291339
							111	28·5	291	36·3	Riv	12330·6	4·090985
							139	12·8	319	19·8	Beavermouth	16018·3	4·204617
							263	27·4	83	20·8	Cherub	9701·8	3·986851
							279	52·3	99	41·0	Sonata	17075·4	4·232371
							292	16·7	112	11·0	Bach	9132·0	3·960567
							316	03·5	136	00·1	Spinster	7262·1	3·861060
							333	14·9	153	11·2	Sentry	12336·8	4·091203
Sentry	51	39	49·76	117	39	24·06	15	45·0	195	48·3	Bush	18064·	4·256810
							81	17·1	261	30·2	Blackwater	19487·	4·289740
							153	11·2	333	14·2	Cupola	12337·	4·091202
							198	33·8	18	31·0	Cherub	12792·	4·106951
							234	16·2	54	08·5	Sonata	13873·	4·142161
Sonata	51	35	27·23	117	49	09·01	54	08·5	234	16·2	Sentry	13873·	4·142161
							99	41·0	279	52·3	Cupola	17076·	4·232391
							119	07·0	299	11·8	Cherub	8239·7	3·915910
Bach	51	35	45·20	117	41	54·12	62	31·2	242	33·6	Spinster	3841·4	3·584488
							112	11·0	292	16·7	Cupola	9132·0	3·960567
							194	29·2	14	28·4	Cherub	4719·8	3·673926
Spinster	51	36	42·51	117	38	57·01	136	00·1	316	03·5	Cupola	7262·1	3·861060
							215	55·5	35	52·4	Cherub	7828·2	3·893661
							242	33·6	62	31·2	Bach	3841·4	3·584488
Sorcerer	51	27	04·02	117	55	35·10	51	42 12	231	52 06	Cherub	18649·8	4·2706735
							135	39 42	315	57 37	Bonney	38243·0	4·5825514
Burniere	50	50	15·41	117	43	03·08	250	11 55	70	09 51	Incomappleux	3322·0	3·5213996
							278	02 26	97	37 16	Begbie	33442·6	4·5848123
							16	32 16	196	40 22	Bonney	42608·0	4·6294916
Cranberry	50	43	31·40	118	10	57·41	343	15 04	163	11 33	Begbie	18510·3	4·2674125
							258	02 25	77	43 19	Mabel	29724·5	4·4731140
							30	43 00	210	57 09	Albert	41800·0	4·6211756

GEODETIC POSITIONS—*Concluded.*

Station.	Latitude.	Longitude.	Azimuth.	Back Azimuth.	To Station.	Distance.	Logarithm.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		Metres.	
Cartier	50 54 46·25	118 03 36·64	257 25 16	77 16 02	Begbie	14293·0	4·155128
			312 33 44	132 16 43	Copeland	34675·5	4·540023
			338 14 26	158 13 10	Mackenzie	6068·7	3·783096
			40 17 32	220 26 01	Albert	19737·5	4·295291
			114 12 57	294 26 50	Incomappleux	23046·0	4·362594
Sproat	50 45 11·08	117 53 59·41	300 13 36	119 56 56	Begbie	29205·5	4·4654647
			330 01 15	149 52 19	Mackenzie	27045·0	4·4320870
			2 39 12	182 40 13	Albert	32847·5	4·5165012
			49 32 58	229 39 23	Incomappleux	12773·2	4·1062983
Armstrong	50 26 06·30	119 04 10·00	327 50 42	147 41 02	Ida	27739·9	4·4431053
			329 09 54	148 55 56	Granite	41480·9	4·6178479
			355 02 29	174 59 59	Bastion	43917·7	4·6426400
			20 23 10	200 31 53	Mara	38076·5	4·5806572
			52 06 35	232 28 37	Mabel	42598·5	4·6293942
XXXIII, XXIII, II	51 00 43·95	118 12 57·46	121 53 42	301 59 28	Mackenzie	10239·8	4·0102905
			135 13 35	315 20 51	Cartier	15555·4	4·1918813
			191 53 38	11 51 39	Begbie	14495·8	4·1612407
Fly	50 43 51·16	118 27 09·53	65 11 06	245 14 54	Granite	6369·0	3·8040718
			117 04 24	297 17 54	Sugarloaf	23096·8	4·3635525
			127 21 58	307 30 04	Ida	15529·8	4·1911670
						Chains.	
Sorcerer	51 27 04·02	117 55 35·10	51 42 12	231 52 06	Cherub		
			135 39 42	315 57 37	Bonney		
			219 14·1	39 12·5	C	184·44	2·265847
			251 58·7	71 57·7	D	76·66	1·884584
A	51 26 03·88	117 56 59·55	145 49·9		B	68·47	1·835500
			215 09·5	35 09·1	C	61·72	1·790446
			6 47·0	186 47·1	D	69·20	1·840113

A	51	26	03·88	117	56	59·55	145	49·9			B	68·47	1·8 5500
							215	09·5	35	09·1	C	61·72	1·790446
							6	47·0	186	47·1	D	69·20	1·840113
B									94	46·3	C	74·26	1·870732
									166	25·3	D	128·97	2·110500
C	51	25	31·03	117	57	36·56	39	12·5	219	14·1	Sorcerer	184·44	2·265847
							343	07·0	163	06·5	Tangier	128·85	2·110096
							20	08·4	200	09·0	D	126·92	2·103530
D	51	26	48·61	117	56	51·04	71	57·7	251	58·7	Sorcerer	76·66	1·884584
							272	55·9	92	54·8	Tangier	81·23	1·909707
Tangier	51	26	51·29	117	58	15·54							
XV, XIX, VI	50	37	10·77	118	44	47·29	62	50 39	242	57 44	Mabel	602·50	2·7799545
							323	34 33	143	33 39	Mab	116·09	2·0647800
Mab	50	38	11·57	118	45	57·85	73	16 47	253	24 46	Mabel	631·67	2·8004900
							143	33 39	323	34 33	XV, XIX, VI	116·09	2·0647800
Bonn	51	50	39·90	117	33	59·90	25	41 23	205	41 54	Cheops	89·57	1·9521813
							112	34 38	292	36 54	Abbott	182·12	2·2603531
Cheops	51	16	32·44	117	33	19·60	174	13 06	354	13 38	Bonney	394·88	2·5964626
							205	41 54	25	41 23	Bonn	89·57	1·9521813
							139	21 43	319	23 28	Abbott	198·54	2·2978528
Abbott	51	14	54·33	117	31	05·48	200	18 56	20	17 44	Bonney	258·22	2·4119959
							292	36 54	112	34 38	Bonn	182·12	2·2603531
							319	23 28	139	21 43	Cheops	198·54	2·2978528
Greeley A	51	01	03·69	118	03	00·20	262	28 38	82	28 09	Greeley B	36·99	1·5680843
							327	34 48	147	34 17	Greeley	72·35	1·8594291
Greeley B	51	01	00·54	118	03	38·05	82	28 09	262	28 38	Greeley A	36·99	1·5680843
							358	09 20	178	09 18	Greeley	65·95	1·8192079
Greeley	51	01	43·45	118	03	40·24	80	26 19	260	34 51	Albert	647·00	2·8109071
							196	43 41	16	42 14	Mackenzie	376·64	2·5759252
							147	34 17	327	34 48	Greeley A	72·35	1·8594291
							178	09 18	358	09 20	Greeley B	65·95	1·8192079

ACCURACY OF THE TRIANGULATION.

In the forty-six triangles considered in the main net, the greatest error of closure of any triangle is 8″·0, and the average error of closure 3″·2.

Obtaining a few quantities as an approximate idea of the probable errors:

For the mean square error of an angle

$$m = \sqrt{\frac{\Sigma \Delta^2}{3n}}$$

Where Δ is the closing error of a triangle and n the number of triangles considered:

In the present case $m = \sqrt{\frac{693 \cdot 6}{3 \times 46}} = \pm 2''\cdot 3$

and the probable error of an angle $= \cdot 67m = \pm 1''\cdot 6$

Taking the actual corrections to the angles, the average correction to an angle is 1″·61 which corresponds to a probable error of about 1″·4.

For the probable error of a side, we have, neglecting the small probable errors of the bases:

$$e_{s_n} = 0\cdot 67\, m \sqrt{u_{s_n}}$$

where u_{s_n} the weight of a side is given by

$$u_{s_n} = \frac{2}{3} \cdot \frac{1}{\delta_s^2} \Sigma_1^n \left\{ \delta_A^2 + \delta_A \delta_B + \delta_B^2 \right\}$$

Where δ_A and δ_B are the differences for a change of 1″ in the log sines of angles opposite a continuation side and opposite a base side respectively in each triangle of the chain of triangles between the base and the side considered and δ_s the tabular difference in the logarithm for one unit in the length of the side a.

The line Bonney to Cornice is about the middle of the triangulation, it being the dividing line between the work done by Mr. Carson and Mr. Bridgland.

Computing the probable error of this side, we have:—

Calculating from the Kootenay base through nine triangles of Mr. Carson's work:

$$e_1 = \pm 0\cdot 70 \text{ metres}$$

Calculating from the Salmon Arm base through twelve triangles of Mr. Bridgland's work:

$$e_2 = \pm 0\cdot 81 \text{ metres}$$

Combining these two results for the probable error of the length of the side Bonney to Cornice considered as a side of the adjusted triangulation:

$$e = \sqrt{\frac{e_1 e_2}{e_1^2 + e_2^2}} = \pm 0\cdot 53 \text{ metres.}$$

or approximately $\frac{1}{41{,}000}$

From the nature of the case, these numbers can only be considered as tolerable approximations.

Blaeberry mountain near the north limit of the railway belt.

Looking north from Bush triangulation station.

CONNECTION OF THE TRIANGULATION WITH THE DOMINION LANDS SYSTEM.

Having obtained the latitudes and longitudes of all the triangulation points, their theoretic positions in the Dominion lands system may be easily calculated by means of tables IV and X of the Supplement to the Manual of Instructions for the Survey of Dominion Lands. Table IV gives the longitude in arc covered by 486 chains at different latitudes, and table X the latitude of the north boundary of each section for the third system of survey.

In a country so rugged as the Rocky and Selkirk mountains, however, there will exist, in general, a considerable difference between the astronomic and geodetic data at any point, and in making any connection between the triangulation and the Dominion lands system, regard must be paid to the different data upon which each is based. Allowance must also be made for slight known irregularities of the Dominion lands system and for the altitude of the land surveyed, since all the data of tables IV and X are calculated for sea-level.

A satisfactory connection of the triangulation to the system was made by extending the triangulation computations eastward to the fifth meridian through previous surveys. The longitude of the fifth meridian in township 24, as thus computed from the longitude at Revelstoke, was found to be 114° 00′ 17″·45. The theoretic longitude of the fifth meridian is 114° 00′ 00″, and a consideration of all the available data would seem to show that its actual longitude does not differ much from this value. Hence a correction of 17″·45 has been made to all the triangulation longitudes. Similarly we find that the sixth meridian as established by a point in township 24 is distant approximately 4° 00′ 06″·63 in longitude from the fifth meridian. Accordingly the longitude of the sixth meridian as derived from the observation at Revelstoke would be 118° 00′ 24″·08. The theoretical longitude should be 118° 00′ 00″, and hence to reduce the triangulation longitudes to the Dominion lands system for points west of the sixth meridian, a total longitude correction of −24″·08 must be applied.

The latitudes, as based on the observations at Sugarloaf and Salmon Arm, were found to be sufficiently in accordance with the Dominion lands system to need no further correction for points between the fifth and sixth meridians. At the sixth meridian, however, as metioned on page 6, there exists a jog of 20·62 chains north, and the latitudes of all points west of the sixth meridian must be corrected for this northerly displacement of the Dominion lands system.

The magnitude of the correction to sea-level is 0·00382 chain per mile for each 1,000 feet of altitude. For the purpose of this work it was considered sufficient to adopt a mean value of 3,500 feet for the elevation of the country between the fifth and sixth meridians, this being approximately the mean elevation of the Canadian Pacific railway. This necessitated a correction in longitude to each triangulation point between these meridians of 8·12 links per range west of the fifth meridian. West of the sixth meridian a mean altitude of 2,000 feet was taken, corresponding to a longitude correction of 4·64 links per range.

In latitude, an elevation of 3,500 feet was taken as the mean elevation of the fifth meridian, from the international boundary to the starting point of the traverse of the Canadian Pacific railway and for north and south section lines, in the Railway Belt. This correction is 8·07 links per township.

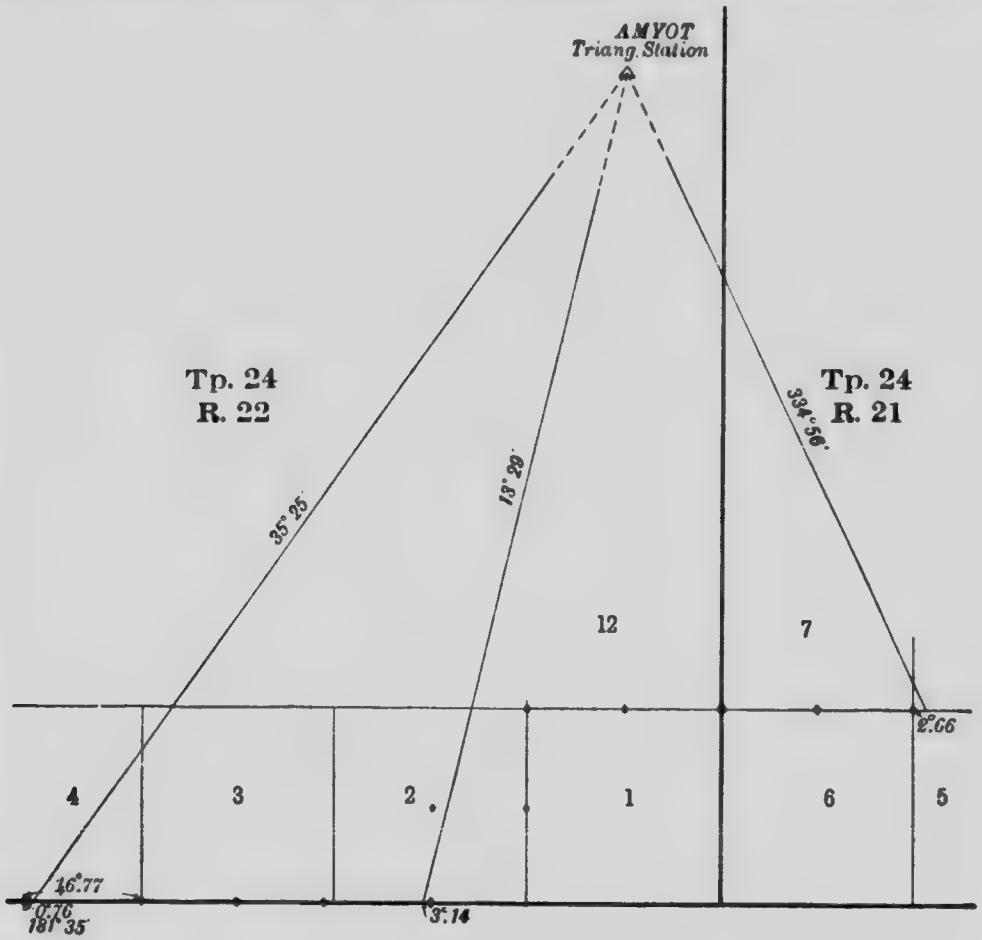
During the progress of the triangulation, ties were made wherever they could easily be effected with existing posts and monuments of the Dominion lands system.

Altogether there are sixteen different connections between the triangulation and points in the Dominion lands system, particulars of which are given below.

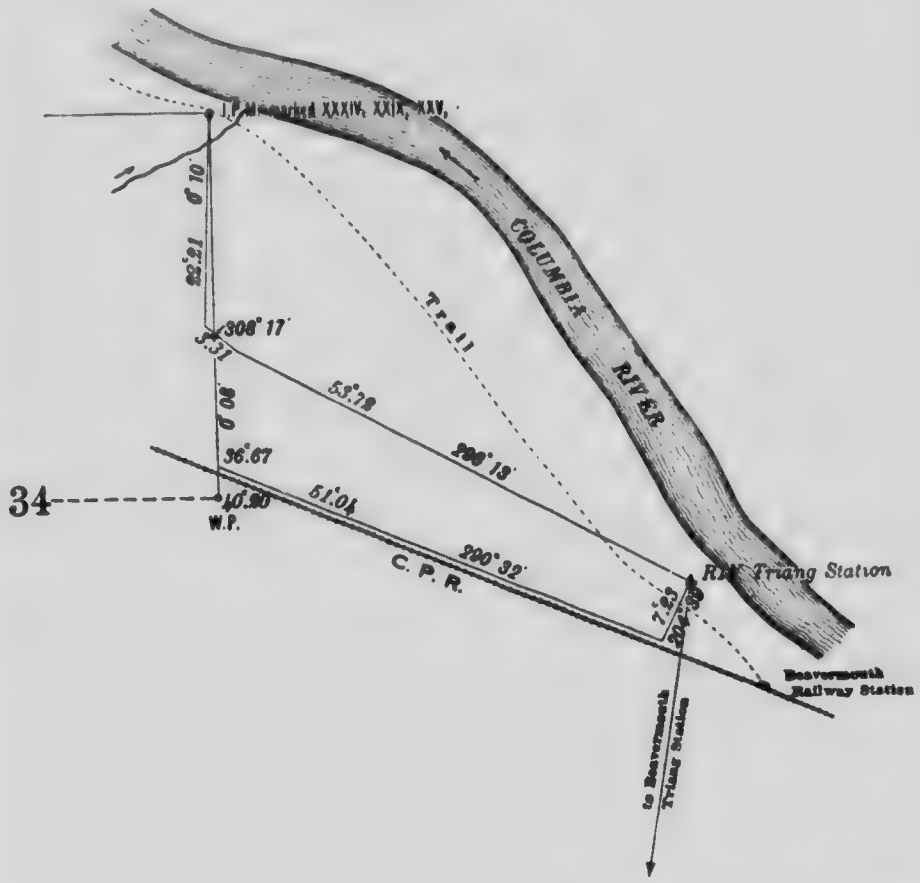
The country in the vicinity of the Kootenay base being subdivided and comparatively level, the connections of the extremities of the base to the nearest quarter-section posts, presented no difficulties to ordinary chaining.

King station was tied to the Dominion lands system by Mr. A. O. Wheeler, D.L.S., in 1904, the station being tied to the northeast corner of township 27, range 19, and the northeast corner of section 23 of the same township.

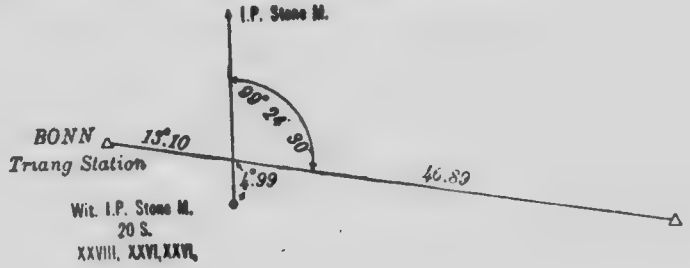
Amyot station, which was established by Mr. Drewry, was observed upon by a subdivider in 1905 from three known points in the Dominion lands system. The results of these ties, however, do not agree within about 2½ chains in the latitude of Amyot, and the mean has been taken.



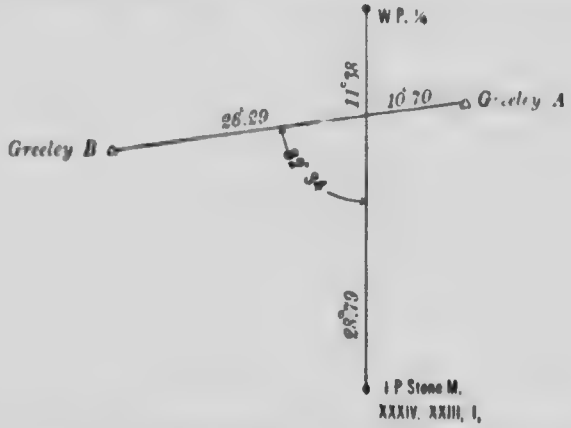
Riv station was connected to the northeast corner of section 34, township 29, range 25, by two traverses which give the position of the triangulation station to the nearest link, as 48·00 chains south and 50·73 chains east of the said corner.



A connection between Bonney triangulation station and the Dominion lands system was established by a measured base running along the railway, and stations on the sides of mount Cheops and mount Abbott. The diagram shows the connection of the base with the section posts.



To connect Albert triangulation station to the Dominion lands system, a subsidiary station Greeley was established, and a base A B measured along the railway just east of Greeley creek. The diagram shows the connection of the base A B with the section posts.



The longitude pier at Revelstoke has been tied, by direct chainage, to the posts on the east boundary of section 34, township 23, range 2.

The northeast corner of section 33, township 23, range 2 was tied to the triangulation stations Begbie and Mackenzie by direct angular measurements between the three stations.

The northeast corner of section 15, township 19, range 6 was tied to Mabel triangulation station by a measured base along the valley of Kingfisher creek, and angles observed between the ends of the base and the triangulation station.

Sugarloaf triangulation station was connected to the northeast corner of section 22, township 19, range 9, by direct chainage.

Each end of the Salmon Arm base was connected to the nearest survey post, and points of intersection of the base with the surveyed lines determined with respect to the section posts.

The table following gives the theoretic position of each triangulation station in the Dominion lands system as computed from its latitude and longitude, after the above-mentioned corrections have been made. Had the subdivision lines been accurately run, the positions of each of these points in the system, as calculated from the triangulation and as determined by the surveyors in the field, would be identical. Since this is not the case, the computed distances given in the table must not be taken as the actual distances of triangulation points from survey posts which are already planted. A comparison of the discrepancies between the computed positions of triangulation points and their positions as determined by direct ties to Dominion lands survey posts in their vicinity will give the relative errors of survey at the posts to which the ties are made. These ties are tabulated and compared in the table on pages 50 and 51. For example, from the table we see that the accumulated errors of survey between the posts in township 24, range 19, near the Kootenay base, and the post to which Bonn station is tied, in township 26, range 26, are about ~~42 + 87 = 79~~ 255 − 176 = 79 links in latitude, and ~~37 + 28 = 68~~ 3 + 62 = 65 links in longitude.

The Van Horne range showing King station from the Emerald Lake road.

Mount Bonney from 'The Loop.'

As has been stated, many of these posts have been established by the running of traverse and subdivision lines over miles of rough country, and furthermore most of the surveys were done or were based on other surveys done in the early survey days, when the surveyors' facilities for standardizing their chains were not as perfect as could be desired. In view of these facts, it is remarkable that the discrepancies due to the irregularities of survey over the large area covered by the triangulation are not considerably higher than is actually the case.

Positions of Triangulation Stations in Dominion Lands System.

West of Fifth Meridian.

Station.	Section, Township and Range in which Station lies.			Distance from Station to Northeast Corner of Section.	
	Sec.	Tp.	R.	Northing Chains.	Easting Chains.
Kootenay Base A	16	24	19	37·20	14·65
Kootenay Base B	35	24	20	9·72	20·64
C	35	24	19	72·12	17·40
D	21	24	20	49·42	38·66
Kapristo	17	26	20	79·81	11·99
Storm	10	26	15	24·57	8·74
King	29	27	19	15·31	77·20
McArthur	3	30	19	35·93	60·14
Laussedat	13	30	22	24·17	2·66
Beaver foot	25	24	19	36·50	12·38
Spillimacheen	21	24	22	10·35	30·87
Amyot	25	24	22	52·06	41·86
Byron	26	24	22	49·54	38·73
Post	16	24	22	39·12	35·77
North Fork	13	26	24	31·55	31·00
Aub	15	26	24	2·68	76·47
Cecil	21	26	24	57·48	67·06
Pick	9	26	24	29·57	36·05
Beavermouth	2	29	25	21·41	80·07
Donald	25	28	24	13·44	18·52
Riv	35	29	25	45·44	28·99
Grand	35	24	25	36·22	13·51
Bonney	10	26	26	41·81	14·44
Bonn	33	26	26	51·61	12·30
Blackwater	29	31	24	13·40	69·06
Cherub	10	30	27	36·85	27·75
Cupola	15	30	26	61·91	33·44
Sentry	20	31	26	77·84	52·49
Sonata	25	30	28	78·63	62·34
Bach	26	30	27	51·08	49·80
Spinster	31	30	26	43·52	41·76
Sorcerer	6	29	28	40·92	28·27
Tangier	2	29	29	66·47	20·32
Tangier M.C. Post No. 2	2	29	29	65·07	18·13
Incomappleux	36	21	28	34·76	61·65
Burniere	5	22	27	59·36	67·95
Sproat	1	21	29	43·83	59·85
Cornice	29	27	27	9·58	61·98
Albert	17	24	28	22·56	44·39

The following triangulation points lie outside of the railway belt. Their positions are given below with reference to the theoretic position for the nearest section corner on the limit of the railway belt.

Blaeberry 3·34 chains North, 39·40 chains East of the NE. cor. sec. 20, tp. 31, rge. 20.
T. B. 415 2·64 chains North, 36·54 chains West of the NE. cor. sec. 10, tp. 31, rge. 20.
Yellow 292·26 chains North, 4·08 chains East of the NE. cor. sec. 36, tp. 33, rge. 23.
Val 46·08 chains North, 35·16 chains West of the NE. cor. sec. 5, tp. 33, rge. 24.
Bush 61·90 chains North, 29·55 chains East of the NW. cor. sec. 2, tp. 33, rge. 26.

Positions of Triangulation Stations in Dominion Lands System.

West of Sixth Meridian.

Station.	Section, Township and Range in which Station lies.			Distance from Station to Northeast Corner of Section.	
	Sec.	Tp.	R.	Northing Chains.	Easting Chains.
Greeley A	2	24	1	49·92	70·50
Greeley B	3	24	1	54·80	26·05
Greeley	10	24	1	60·38	28·16
Cartier	34	22	1	66·37	25·05
Mackenzie	16	23	1	27·69	55·38
Revelstoke	35	23	2	75·98	75·80
I.P. 33-23-2	4	24	2	80·31	0·15
Carnes	29	27	1	10·67	49·51
Copeland	7	25	3	30·32	79·96
Begbie	20	22	2	61·07	73·35
Griffin	1	23	5	43·14	2·80
Cranberry	26	20	2	56·65	50·64
Mabel	2	20	5	44·94	35·85
I.P. 15-19-6	22	19	6	77·96	4·00
Mab	27	19	6	65·05	72·92
Mara	2	21	7	49·52	72·70
Quest	26	23	7	59·86	21·97
Bastion	36	21	9	50·37	30·14
Granite	6	21	10	54·55	7·29
Ida	26	19	10	12·61	6·49
Sugarloaf	27	19	9	67·96	3·79
Fly	27	20	11	26·31	5 74
South End	5	20	10	55·08	55·59
North End	24	20	10	42·20	62·92

The triangulation station Armstrong lies outside of the railway belt. Its position referred to the nearest section corner on the belt limit is given below.

Armstrong 52·28 chains South, 30·86 chains West of the SE. cor. sec. 20, tp. 17, rge. 8.

Comparison of Actual with Theoretic Positions

Station.	Post of D.L. System to which tie is made.
West of Fifth Meridian.	
Kootenay Base A	Quarter-section post on east boundary of sec. 16, tp. 24, rge. 19
Kootenay Base B	Section post at northeast corner of sec. 35, tp. 24, rge. 20
King	Result of several ties reduced to northeast corner of tp. 27, rge. 19
Amyot	Result of two ties reduced to the section post at northeast corner of sec. 1, tp. 24, rge. 22
Riv	Section post at northeast corner of sec. 34, tp. 29, rge. 25
Bonn	Witness post twenty chains north of northeast corner of sec. 28, tp. 26, rge. 26
West of Sixth Meridian.	
Greeley A	Section post at northeast corner of sec. 34, tp. 23, rge. 1
Greeley B	Section post at northeast corner of sec. 34, tp. 23, rge. 1
Revelstoke	Witness post sixteen chains north of northeast corner of sec. 27, tp. 23, rge 2
I.P. 33-23-2	Section post at northeast corner of sec. 33, tp. 23, rge. 2
I.P. 15-19-6	Section post at northeast corner of sec. 15, tp. 19, rge. 6
Sugarloaf	Section post at northeast corner of sec. 22, tp. 19, rge. 9
North End Base	Wooden post at centre of sec. 24, tp. 20, rge. 10
Intersections of Salmon Arm base line with section lines. I	Section post at northeast corner of sec. 10, tp. 20, rge. 10
I	Section post at northeast corner of sec. 9, tp. 20, rge. 10.
I	Section post at northeast corner of sec. 9, tp. 20, rge. 10
F	Section post at northeast corner of sec. 4, tp. 20, rge. 10
K	Section post at northeast corner of sec. 5, tp. 20, rge. 10
K	Quarter post on east boundary of sec. 5, tp. 20, rge. 10
South End Base	Section post at southwest corner of sec. 5, tp. 20, rge. 10

OF SOME DOMINION LANDS SURVEY POSTS.

Distance from Triangulation Station to D.L. System Post.								Errors of D.L. System.			
By actual measurement.				As computed for a theoretic D.L. system.							
Latitudes.		Departures.		Latitudes.		Departures.		Latitudes.		Departures.	
Chains.		Chains.		Chains.		Chains.		Chains.		Chains.	
S	0·50	E	14·62	S	3·05	E	14·65	N	2·55	W	0·03
N	12·28	E	20·53	N	9·72	E	20 64	N	2·56	W	0·11
N	97·27	E	403·12	N	95·91	E	401·97	N	1·36	E	1·15
S	267·78	E	41·74	S	269·94	E	41·83	N	2·16	W	0·09
N	48·00	W	50·73	N	45·40	W	51·86	N	2·60	E	1·13
S	7·13	E	12·92	S	8·89	E	12·30	N	1·76	E	0·62
S	30·19	W	10·56	S	30·54	W	10·63	N	0·35	E	0·07
S	25·35	E	26·11	S	25·70	E	26·05	N	0·35	E	0·06
N	11·59	W	5·32	N	11·52	W	5·35	N	0·07	E	0·03
	0·00		0·00	S	0·19	E	0·15	N	0·19	W	0·15
	0·00		0·00	S	2·54	E	4·00	N	2·54	W	4·00
S	9·93	E	1·43	S	12·54	E	3·79	N	2·61	W	2·36
N	4·56	E	21·91	N	1·95	E	22·39	N	2·61	W	0·48
	0·00	E	45·29	S	2·63	E	45·63	N	2·63	W	0·34
	0·00	W	35·71	S	2·61	W	35·47	N	2·61	W	0·24
N	28·64		0·00	N	26·03	E	0·24	N	2·61	W	0·24
S	51·70		0·00	S	54·47	E	0·24	N	2 77	W	0·24
N	13·04		0·00	N	10·56	E	0·15	N	2·48	W	0·15
S	27·16		0·00	S	29·69	E	0·15	N	2·53	W	0·15
S	23·00	W	25·57	S	25·46	W	25·55	N	2·46	W	0·02

THE TRIANGULATION AS A BASE FOR OTHER SURVEYS.

During the course of a surveyor's work in the region covered by the triangulation he may require to make use of the triangulation in order to locate the position which a certain point would occupy in the Dominion lands system, or to use it as a base to obtain a point from which to start a subdivision or other survey.

The best method of procedure in any particular case must depend on the nature of the country and the exact work to be done, and must therefore be left to the surveyor's judgment. A few general points may here be mentioned.

The work of the subdivider may be considered under two heads, according as the triangulation station in the vicinity is easily accessible or difficult of access.

In the former case, where the triangulation station may be easily reached and occupied, as in the case of stations near the Kootenay and Salmon Arm bases, or such points of the triangulation as Post, Aub, Riv, and Val, the surveyor is provided with a point whose position in the Dominion lands system is known and given in the tables on pages 48 and 49. The table of geodetic positions on pages 32 to 41 furnishes him with the azimuths from the point to the other visible triangulation stations, so that by sighting on one of these stations he is at once provided with an initial azimuth.

The surveyor will now proceed by traverse or triangulation according to his judgment. Proceeding by triangulation, a base of known length will be required. It may, however, be possible to evade the difficulties of measuring and connecting up a base, by obtaining a well-conditioned triangle having the length from the accessible triangulation station to another (inaccessible) triangulation station as a side. The length of such a side will be found in the table of Geodetic Positions. In this case, of course, only two angles of the triangle could be measured.

In the case where the triangulation station is so difficult of access as to be considered inaccessible from the subdivider's point of view, as is the case with many of the primary stations, triangulation methods must be resorted to, and an azimuth observation and a measured base are necessary. In fairly level country a base may be found with the triangulation signal visible from both its ends, and of such a length as to provide a sufficiently large angle at the apex. Under less favourable circumstances, it may be necessary to develop a small system of triangulation with temporary stations on neighbouring hills to connect the triangulation station with a measured base. Whenever a base is required, its length must be determined by careful chaining and check-chaining. The connection of Bonney to the Dominion lands system, of Blaeberry to the post T.B. 415, and of Sorcerer to the Tangier mining claim are examples of such connections.

The object of the subdivider will, of course, be to determine the position of some point of his work in the Dominion lands system, by computing its latitude and departure from the triangulation station. To do this, it may be necessary to compute the azimuths, latitudes, and departures over lines of considerable length, where the correction for convergence of the meridians cannot be

neglected. The magnitude of the convergence is given in the astronomical field tables, and is a little over one minute per mile of easting or westing for the area covered by the triangulation.

In computing the latitude and departure over a line of considerable length, the azimuth taken for the computation should be the azimuth of the line at its mid-point, that is, the azimuth of the line at one of its ends plus or minus half the convergence over the whole line. This method will be sufficiently accurate for ordinary work, and need only be employed for lines over two miles in length.

In the angular measurements, both verniers should be read, and each angle should be measured with the transit "circle right" and "circle left." In the case where only two angles of a triangle can be measured, special care must be exercised in their measurement, as there is then no direct check on the angles. Work of this nature must be checked, when possible, by a second triangle independent of the first, or if this is not possible, the surveyor should have the angles re-measured independently of his first measurement, either by himself or his assistant.

Triangles with small angles should be avoided as much as possible, although they may often be found necessary. When such a triangle is necessary, the surveyor must remember that when a small angle enters into the computation the accuracy of the computed side will depend principally upon the accuracy of the small angle, and any small error in this angle will produce a comparatively large error in the length of the computed side. To obtain good results, therefore, the surveyor must concentrate his attention on an accurate measurement of the small angle. When the angle can be directly measured, this may be accomplished by repeated measurements of the angle with special attention to the level and other sources of error. Usually, however, the small angle will be the angle at some distant triangulation station which the surveyor finds himself unable to measure. This is the most unfavourable case for accurate work, and the surveyor must then endeavour to measure the other two angles with great care in order that the calculated value of the small angle may be sufficiently accurate.

When the surveyor has occasion to disturb any triangulation monument he must be careful to rebuild or replace it in its exact former position. The department will be pleased to be notified of any triangulation monument which has evidently been disturbed or is in bad repair.

For converting lengths given in metres to English measure, the following multipliers will be useful:—

	Multiplier.	Logarithm.
Metres to miles	0·000621372	4·7933515
Metres to chains	0·04971	2·6964415
Metres to feet	3·28084	0·5159854

ELEVATIONS.

The only data available for the computations of the elevations, was the line of levels along the Canadian Pacific railway. Connection was made with these levels at Beavermouth railway station, Revelstoke railway station, and Salmon Arm railway station.

Throughout the course of the triangulation, vertical angles were observed whenever possible. Although in many cases vertical angles between two stations were observed in both directions, yet the observations at the different stations were in general taken under very different weather conditions.

The ordinary formula for single observations was applied

$$\Delta h = K \tan \alpha + \frac{1-2m}{\rho} K^2 + \frac{1-m}{\rho} K^2 \tan^2 \alpha$$

where α is the altitude of the station sighted

K the length of the line sighted over

ρ the radius of curvature of the line

and m the coefficient of refraction.

A mean value of 0·07 was taken for m, this being the value adopted by the United States Coast and Geodetic Surveys after making special observations extending over a lengthy period for its determination.

Taking a mean value for ρ for the territory surveyed of $2 \cdot 094 \times 10^7$ feet, the formula may be conveniently reduced for computation.

$$\Delta h \text{ (feet)} = A K \tan \alpha + B K^2 + C (A K \tan \alpha)^2$$

where $\log A = 0 \cdot 51599$

$\log B = \bar{7} \cdot 3445$

$\log C = \bar{8} \cdot 6475$

and K is in metres.

Having obtained the differences of altitude between the different stations, they were adjusted by Least Squares, the net being divided into five sections and each section adjusted independently.

ELEVATIONS OF TRIANGULATION STATIONS.

Station.	Elevation Feet.	Station.	Elevation Feet.
Kootenay Base A	2 682	Spinster	8 467
Kootenay Base B	2 691	Sorcerer	10 394
C	8 013	Tangier	4 781
D	4 872	Incomappleux	8 781
Kapristo	8 930	Burniere	8 317
King	9 488	Sproat	8 024
Laussedat	10 035	Cornice	8 997
Blaeberry	9 640	Albert	9 621
Beaverfoot	7 964	Greeley A	3 239
Spillimacheen	9 449	Cartier	8 563
Amyot	8 850	Mackenzie	8 073
Byron	8 851	Revelstoke	1 594
Post	5 071	I.P. 33-23-2	1 524
North Fork	8 967	Carnes	10 007
Aub	5 982	Copeland	8 472
Pick	6 797	Begbie	8 963
Beavermouth	7 892	Griffin	7 082
Donald	8 811	Cranberry	8 832
Riv	2 425	Mabel	7 009
Grand	10 492	I.P. 15-19-6	1 625
Bonney	10 194	Mara	7 201
Bonn	3 606	Queest	6 846
Blackwater	8 964	Bastion	4 416
Bush	8 197	Granite	5 014
Yellow	8 256	Ida	4 934
Val	2 526	Sugarloaf	2 582
Cherub	9 739	Armstrong	5 455
Cupola	8 678	Fly	5 749
Sentry	8 344	South End Base	1 179
Sonata	9 892	North End Base	1 167
Bach	8 485		

DESCRIPTION OF STATIONS.

KOOTENAY BASE.—*Station A*, which marks the southerly end of the base, is distant 14·62 chains west and 0·50 chain north of the wooden post marking the quarter-section corner on the east boundary of section 16, township 24, range 19, west of the fifth meridian.

The end of the base or geodetic point is the intersection of a pair of fine lines at right angles to each other, stamped on the head of a brass bolt 6 inches long and three-quarters of an inch in diameter, with a flat head 1½ inch square. The head of the bolt is also stamped with the letter "A." The bolt is set in concrete 3 feet below the surface of the ground, and is covered with loose earth. For surface marks there are four iron reference bolts 15 inches long and 1 inch in diameter which bear north, east, south and west respectively from the geodetic point, and are each 6 feet from it.

Station B, which marks the northerly end of the base, is 20·53 chains west and 12·28 chains south of the iron post and mound marking the northeast corner of section 35, township 24, range 20, west of the fifth meridian. The geodetic point is marked similarly to station A except that the brass bolt bears the letter "B" stamped upon its head.

Station C, for the projection of the Kootenay base line, is on the summit of the Beaverfoot range at an altitude of about 8,000 feet. The mountain is easily reached by a pony trail running from the Columbia Valley wagon road at a point near "Biebernitz" ranch and leading up the side of the mountain. Horses lightly packed may easily be taken to timberline.

The station is marked with the usual brass bolt securely cemented in a hole drilled in the rock. The head of the bolt is stamped with the letter "C" and a triangle, the apex of the triangle which faces north being the geodetic point. Three reference bolts are also firmly cemented in the rock, each being 6 feet horizontally from the geodetic point, and bearing respectively north, south, and west from it. Directly over the brass bolt a conical stone cairn was erected, 4 feet in diameter at the base and 6 feet high, the pointed top being vertically over the geodetic point. White cotton was wound around the cairn to serve as a signal.

Station D, for the projection of the base line, was established on a wooded ridge at an altitude of about 4,900 feet on the west side of the Columbia valley, opposite the base line. The station is just south of the pass leading from Carbonate Landing to Spillimacheen valley. A spot on the ridge was cleared of timber so as to give unobstructed vision towards stations C, Kapristo, and Spillimacheen.

The station is marked by the usual brass bolt, cemented in a hole drilled in the solid rock, 12 inches below the surface of the ground. The head of the bolt is stamped with the letter D and a triangle, having its apex facing north, at the centre of the bolt. The apex of the triangle is the geodetic point. Directly over the geodetic point was erected a wooden signal in the shape of a tetrahedron 5 feet high. The signal was covered with white cotton to assist in clearness of vision.

KAPRISTO.—Kapristo station is situated on the summit of Kapristo mountain, one of the most northerly and highest peaks of the Beaverfoot range. The station may be reached from Carbonate Landing via an old smugglers' trail to a high pass over the Beaverfoot mountains, then northerly along the summit of the range.

The station is marked with the usual brass bolt, cemented in a hole drilled in the rock. The flat head of the bolt is stamped with the letter "E" and a triangle with its apex at the centre of the head. The apex of the triangle faces north, and is the geodetic point. Directly over the geodetic point a conical stone cairn was erected, 5 feet in diameter at the base, 1 foot at the top, and 6 feet high. White cotton was wound around the cairn to aid as a signal. Four reference bolts were also securely cemented in the rock, each being 6 feet distant horizontally from the geodetic point, and bearing north, east, south, and west from it.

STORM.—Storm station is on the summit of Storm mountain. The mountain is visible from Castle Mountain railway station, being about 6 miles distant in a southwesterly direction.

The station is marked by the usual brass bolt cemented in a hole drilled in the rock. The head of the bolt is stamped with a triangle and the number

Grand Glacier en route for Grand Mountain over mountains east of Glacier House. The photograph shows the bottom of a crevasse which was too wide to leap and 200 feet deep.

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XIV. The apex of the triangle is at the centre of the head of the bolt, faces north, and is the geodetic point. Four iron reference spikes are set in the rock and fixed with cement, being each 6 feet distant from the geodetic point, and bearing respectively north, east, south, and west from it. Over the geodetic point is a conical stone cairn 8 feet in diameter at the base, 2 feet diameter at the top, and 8 feet high. This cairn is surmounted by a tin signal in the form of a truncated cone 2 feet high, which is filled with stones and securely wired to the cairn.

KING.—King station, located by Mr. W. S. Drewry, is situated on the summit of mount King, at the southerly end of the Van Horne range, and distant about 4 miles in a northwest direction from Ottertail railway station.

The station is marked by the usual brass bolt stamped with a triangle and the number XVII. Three iron bolts are cemented in holes drilled in the rock, each being 6 feet distant from the geodetic point, and bearing east, south, and west from it. The stone cairn over the geodetic point measures 7 feet in diameter at the base, 2 feet at the top, and is 6 feet 6 inches high. It is surmounted by a truncated cone of tin, 2 feet high.

MCARTHUR.—McArthur station is situated on the summit of mount McArthur at an altitude of about 9,880 feet. It can be reached by trail from Emerald lake over the Yoho pass, and then northerly up the Yoho river. After skirting Duchesnay lake, a branch trail ascends the Little Yoho river almost to Kiwetinok pass. From here the mountain lies about 2 miles to the northwest, and the summit may be reached after a climb of about three or four hours.

The station is marked in the usual manner, by a brass bolt cemented in a hole drilled in the rock and stamped with a triangle and the number XVIII. The apex of the triangle, at the centre of the head of the bolt, is the geodetic point. Two iron bolts are cemented in holes drilled in the rock, one being due south of the geodetic point and distant 7 feet from it, and the other due west and distant 6 feet therefrom. The stone cairn measures 7 feet diameter at the base, 2 feet at the top, and is 7 feet high. It is surmounted by a truncated cone of tin.

LAUSSEDAT.—Laussedat station is situated on Laussedat mountain between the Waitabit and Blaeberry valleys. It may be reached from Golden via Moberly and trail up the east side of Blaeberry river.

The station is marked by a brass bolt stamped in the usual manner. As reference marks, two iron bolts are set in the rock and fixed with cement, one 6 feet due south, and the other 4 feet 6 inches due west of the geodetic point. The stone cairn over the geodetic point measures 6 feet in diameter at the base, 1 foot at the top, and is 6 feet high.

BLAEBERRY.—Blaeberry station is situated on a mountain about 3 miles east of mount Mummery. It may be reached from Golden by trail up Blaeberry river and then up Mummery creek and glacier to the west slope of the mountain. The station is placed on a peak a little to the south of the main and higher peak.

The geodetic point is marked by the usual brass bolt stamped with "XIX A" and the usual triangle. The reference marks are two iron bolts firmly fixed

in the rock with cement, one bearing 6 feet due north and the other 5 feet due east of the geodetic point. The stone cairn erected over the geodetic point measures 4 feet diameter at the base, and is 6 feet 6 inches high. A band of white cotton is wound around the cairn about a foot from the top to assist as a signal.

A connection was made between Blaeberry triangulation station and a wooden post marking the northwest corner of timber berth 415. This post, which was planted by Mr. J. A. Kirk, D.L.S., in 1907, for the north limit of the Railway Belt, is situated on the left or east side of Blaeberry river, and on a cut line running east and west. It is a 5-inch squared wooden post, standing 18 inches high and is marked "T.B. 415". Another post was found on said cut line, 24·84 chains east and marked "T.B. 415" and "W.P.E. 55·16."

Beaverfoot.—Beaverfoot station is situated on a peak of the Beaverfoot range, about 25 miles southeast of Golden. The wagon road along the Columbia river, at about 12 miles above Carbonate Landing is distant about 3 miles from the station, which here bears N. 30° E. The summit is long and narrow, consisting of three conjoined peaks.

The station is marked by a brass bolt stamped with the number XX and the usual triangle. For reference marks, three iron bolts were fixed with cement in holes drilled in the rock, each being 6 feet distant horizontally and bearing north, south, and west from the geodetic point. The cairn marking the station is 5 feet diameter at its base and 8 feet high, and is surmounted by a tin signal. The cairn is painted white that it may be more easily distinguished at a distance from the grey syenite-gneiss of the mountain.

Spillimacheen.—Spillimacheen station is situated on a peak about 2 miles westerly from the first bald peak of a ridge of mountains lying between the north and middle forks of the Spillimacheen river, and about 30 miles from the confluence of that river with the Columbia river. It may be reached from Golden by wagon road 17 miles up the Columbia to the Carbonate Landing where the Columbia river is crossed. A good pack trail leads southwards to a low pass at the southerly end of the Dogtooth mountains, 5 miles from Carbonate Landing. Here the trail divides and the trail to the right leads up the left bank of the north fork of the Spillimacheen river. From a point about 12 miles above the dividing of the trail the river must be crossed and the ascent of the mountain made. The station may also be reached from the middle fork trail and the south side of the mountain.

The usual brass bolt stamped with the customary triangle and the number XXI marks the geodetic point. As reference points, two holes were drilled in the rock each 6 feet distant and bearing respectively south and west from the geodetic point. The stone cairn built at the station was 4 feet in diameter at the base and 6 feet high. A band of white cotton was wrapped around the cairn about a foot from the top to assist as a signal. Three subsidiary stations in the neighbourhood of Spillimacheen station were also observed on.

Amyot station is on the most easterly mountain of the range. It is marked only by a stone cairn 7 feet high.

This location was selected by Mr. W. S. Drewry for Spillimacheen station. It was not suited for a primary station, however, as stations farther west are invisible therefrom. It has been used as a secondary station.

Byron station is situated on a lower peak about a mile west of Amyot station. It is marked only by a stone cairn 8 feet high.

Post station is a reference station in the valley of the middle fork of the Spillimacheen river. It is a spruce post 6 inches square and 3 feet long, marked "Sta XXI C" The post is just a few feet south of the pack trail on the north side of the Spillimacheen river.

NORTH FORK.—North Fork station is situated on a mountain about 16 miles up the north fork Spillimacheen river from Spillimacheen station. It may be reached by proceeding up Baird brook for about a mile and a half from its confluence with the north fork Spillimacheen, when a large slide on the north side of the mountain gives a gradual slope to the summit.

The usual brass bolt stamped with the customary triangle and the number XXII marks the geodetic point. As reference marks, four iron bolts are cemented in holes drilled in the rock, each 6 feet distant, and bearing north, east, south, and west, respectively, from the geodetic point. The stone cairn is 6 feet in diameter at the base, 2 feet at the top and 6 feet high.

Aub station is a squared wooden post in a stone cairn in the valley of the north fork Spillimacheen river. It is just west of the pack trail on the east or left side of the river, and about half a mile north of the confluence of the north fork Spillimacheen with Baird brook. The wooden post is marked with "Sta XXII A"

Cecil station is on the summit of Bald mountain at an altitude of about 7,650 feet, with the north fork of the Spillimacheen river between it and North Fork station. It is marked by a cairn established by Mr. Wheeler and called by him "Bald Mt. South No. 2."

Pick station is Mr. Wheeler's cairn "Spillimacheen" placed on the Bald mountain ridge about 2 miles south from Cecil station.

BEAVERMOUTH.—Beavermouth station is the most northerly mountain of a low range lying between Quartz creek and Beaver river, and immediately south of Beavermouth village.

The station is marked by the usual brass bolt stamped with the customary triangle and the number XXIII. For reference points, four iron bolts are cemented in holes drilled in the rock, each being 6 feet distant and bearing north, east, south, and west, respectively, from the geodetic point. The stone cairn is 7 feet diameter at the base, 2 feet at the top, and 8 feet high, and is surmounted by a tin signal, whose top is 10 feet vertically above the geodetic point. The cairn was painted white in order to render it more easily discernible.

Donald station is a large stone cairn on a mountain just south of Donald railway station.

Riv station. A connection was made with the post marking the northeast corner of section 34, township 29, range 25, by a traverse from Riv station—a point on the north side of the trail near the mouth of the Beaver creek.

GRAND.—Grand station is situated on Grand mountain, near the head of the Beaver river, on the left side. It may be reached from Bear Creek railway station up the Beaver river trail to Grand glacier. Grand mountain divides this glacier into two forks.

The station is marked by the usual brass bolt stamped with a triangle and the number XXIV. As reference marks, four iron bolts are cemented in holes drilled in the rock. A conical stone cairn was built over the geodetic point.

BONNEY.—Bonney station is situated on the summit of mount Bonney in the Selkirk range. The summit of the mountain extends for 200 feet east and west, and consists of three united peaks of almost equal height; the middle peak was selected for the station. It may be reached from the north side from Glacier via Loop creek and mount Green, or by way of the Asulkan pass and mount Swanzy. Another route is from the Canadian Pacific railway track up Flat creek to Flat Creek pass, when timber-line can be reached in about two hours and a half, and mount Bonney is in full view about 4 miles away in a northeasterly direction.

The station is marked by the usual brass bolt stamped with a triangle and the number XXV. For reference marks, two iron bolts are cemented in holes drilled in the rock, each being 6 feet distant and bearing north and east, respectively, from the geodetic point. Two other reference points are also marked, being crosses cut in the rock each distant 6 feet and bearing south and west, respectively, from the geodetic point. The stone cairn erected at the station measures 6 feet at base, 2 feet at top and 6 feet 6 inches high, and is surmounted by a tin signal.

ALBERT.—Albert station is situated on a peak adjoining and projecting from North Albert mountain. It is reached from Twin Butte railway station up a ridge projecting between the railway and East Twin creek.

The station is marked by the usual brass bolt stamped with the usual triangle and the number XXVII. Bolts set in the rock serve as reference points. The stone cairn is 5 feet diameter at the base, and 7 feet high.

BLACKWATER.—Blackwater station is on the summit of the highest mountain of the Blackwater range. It may be reached from Donald railway station by the government pack trail to the Big Bend of the Columbia river, as far as Blackwater lake, where a trail leads northeasterly up Blackwater creek to an old deserted mine at timber-line. From here the ascent to the station can be easily made in three hours.

The station is marked with the usual brass bolt stamped with a triangle and the number XXVIII. As reference marks, three iron bolts are cemented in the rock, each distant 6 feet horizontally and bearing east, south, and west, respectively, from the geodetic point. The stone cairn is 7 feet 6 inches high and encircled with a band of white cotton.

BUSH.—Bush station is situated on the summit of a mountain about 4 miles north of Bush river crossing. It may be reached by following the government pack trail from Donald to the Big Bend as far as Bush river crossing. Here a hog's back between the two Cygnus lakes leads north to the mountain.

Fording Bow river near Castle mountain, Alberta.

'The Farm' situated up the north fork of the Illecillewaet river en route to the Waverly and Tangier mines.

The station is marked with the usual brass bolt stamped with a triangle and the number XXIX. Four reference bolts are securely cemented in the rock, each distant 6 feet from the geodetic point and bearing respectively north, east, south, and west from it. The stone cairn raised over the geodetic point is 9 feet high, and is made more easily discernible by a band of white cotton wound around it.

YELLOW.—Yellow station is situated on Yellow mountain. The mountain may be reached from Donald by the government trail to Bush river. A trail up this stream, about 19 miles to Bush river forks, and then up the south fork for a mile and a half leads to the southwesterly slope of the mountain.

The station is marked by the usual brass bolt stamped with a triangle and XXIX A. As reference marks, three iron bolts were cemented in the rock, each distant 6 feet, and bearing east, south, and west, respectively, from the geodetic point. The stone cairn above the geodetic point is 7 feet high and is wound with a band of white cotton about a foot from the top.

Val station was established as a reference station in Bush river valley, on the right or north bank of the river, and about a mile and a half below the forks. The station is marked by a cedar post 5 inches square and 4 feet long. The post is situated in a cleared space 10 feet from the bank of the river and about 8 feet above the water. The post is marked "Sta. XXIX B" on one side and on another side "Triangulation Survey in British Columbia."

CHERUB.—Cherub station is situated on Cherub mountain, and may be reached from Six-mile railway station by trail up the north fork of Six-mile creek to Sunbeam lake at the head of Spinster creek, from which place Cherub mountain is about 3 miles distant in a southwesterly direction.

The station is marked by the usual brass bolt stamped in the usual manner. As reference points, two iron bolts are set in holes drilled in the rock, one 5 feet due north, and the other 6 feet due east from the geodetic point. The stone cairn over the geodetic point is 5 feet diameter at the base and 8 feet high, and has a band of white cotton wound around it to assist as a signal.

[illegible] secondary stations were established on neighbouring peaks.

Cupola station is on Cupola mountain, a peak of the Esplanade range.

Scotty station is on Scotty mountain, which is the most northerly mountain of the Esplanade range, and overlooks the mouth of Gold creek and Bush river valley.

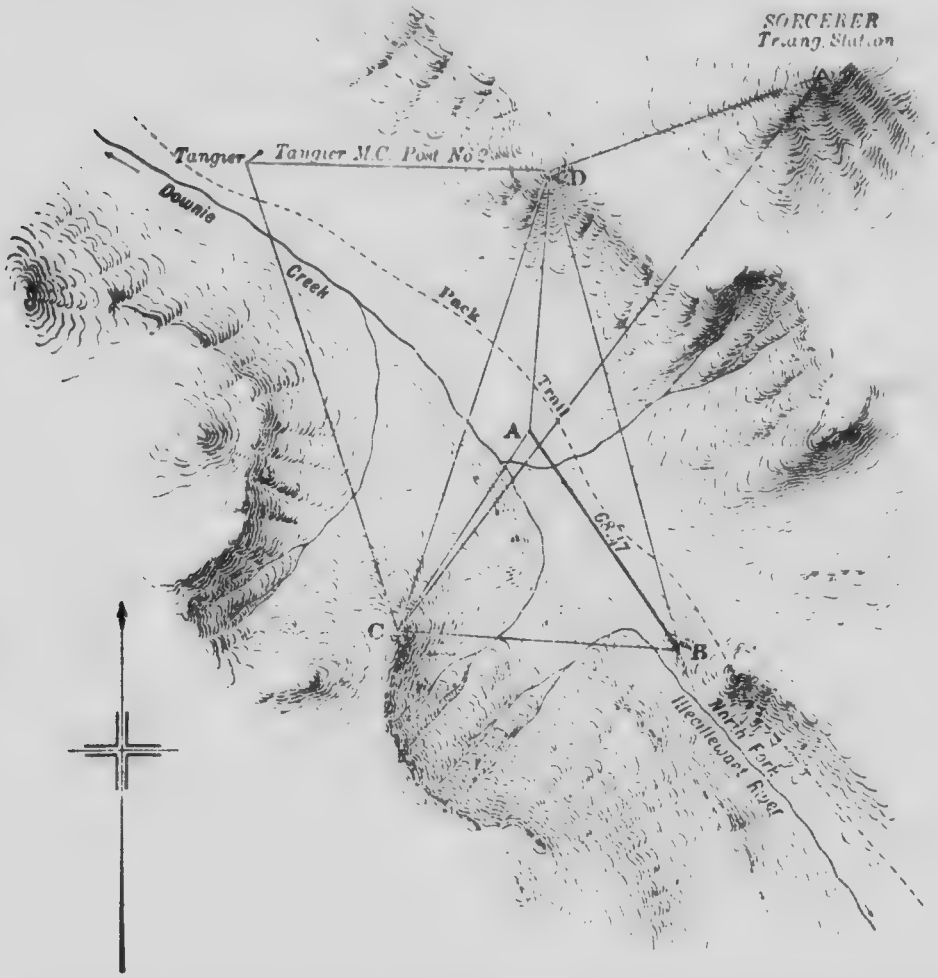
Sonata station is on Sonata mountain.

Bach and *Spinster* are on neighbouring peaks, each at an altitude of about 8,500 feet.

SORCERER.—Sorcerer station is on Sorcerer mountain. The mountain lies on the northeasterly side of the pass between the heads of the north fork Illecillewaet river and Downie creek, and is about 12 miles above Cornice triangulation station in a northwesterly direction. It may be reached from Albert by the old wagon road to the Waverly and Tangier mines; the mountain is difficult to scale.

The station is marked with the usual brass bolt and a stone cairn, but no reference marks are set.

By means of a base line A B and the secondary stations C D and Tangier, Sorcerer station was connected with one of the survey posts of the Tangier mines, thus locating the positions of these posts relative to the Dominion lands system. The base is on the level summit of the pass between the north fork Illecillewaet river and Downie creek. C and D are on neighbouring peaks, and Tangier is in the Downie Creek valley, nearly 2,000 feet below the pass Station A is marked by a squared wooden post marked "31 A".



TANGIER MINING CLAIM.—Post No. 2 of the Tangier Mining Claim is a 5-inch squared wooden post in a stone mound. The post is marked "Tangier M.C. Post No. 2." Beside it in the same stone mound is another wooden post marked "Trinity M.C. Post No. 1."

INCOMAPPLEUX.—Incomappleux station is situated on a mountain about 6 miles northwest of the old mining town of Cambourne. It may be reached by following the trail from Cambourne to the Burniere mine, from whence the station may be reached in four or five hours by proceeding over the south

shoulder of Burniere mountain on which Burniere signal is placed; and then crossing some large snowfields to the base of the peak. The signal is placed near the eastern end of the long ridge which forms the summit of the mountain.

The geodetic point is marked by the usual brass bolt stamped with a triangle and the number XXXII. As reference marks, four iron bolts were cemented in the solid rock, being placed as follows: Bolt "I" is 4 feet due north of the geodetic point, bolt "II" is 5 feet distant at a bearing of 65° 00′, bolt "III" is 5 feet distant at a bearing of 200° 00′, bolt "IIII" is 4 feet distant at a bearing of 235° 00′ from the geodetic point. The stone cairn over the brass bolt is 4 feet diameter at the base and 6 feet 6 inches high.

BURNIERE.—Burniere station is situated on a peak about 4 miles northwest of the old mining town of Cambourne, and overlooks the Incomappleux valley. It may be easily reached by following the trail to the Burniere mine, which is close to timberline, and from here the signal may be reached in less than two hours.

The station is marked by the usual brass bolt stamped with the customary triangle and the number XXXII A. Four iron reference bolts are cemented in the solid rock and placed as follows, all bearings and distances being given from the geodetic point: Bolt "I" bears due north and is distant 5·5 feet; bolt "II" bears 84° 00′, distance 6·25 feet; bolt "III" bears 145° 30′, distance 7·9 feet; bolt "IIII" bears 278° 00′, distance 12·6 feet. The stone cairn over the geodetic point is 5 feet diameter at base and 8 feet 4 inches high.

SPROAT.—Sproat station is situated on mount Sproat. It may be reached from the lumbering town of Comaplix on Arrow lake. The station is marked only by a stone cairn 5 feet 6 inches diameter at the base and 8 feet 6 inches high.

CARTIER.—Cartier station is situated on mount Cartier, which lies a short distance southeast of Revelstoke. It is most easily reached from Greenslide railway station on the Arrowhead branch of the Canadian Pacific railway, comparatively open slopes leading directly to the mountain.

The station is situated on the northerly part of the summit, and is marked by the usual brass bolt stamped with the usual triangle and the number XXXIV. Two reference bolts were placed in the solid rock, one 6 feet north and the other 6 feet south of the geodetic point. Over the geodetic point a stone cairn was built measuring 5 feet diameter at the base and 8 feet high.

MACKENZIE.—Mackenzie station is situated on mount Mackenzie, a short distance east of the town of Revelstoke, and may be easily reached from here The signal is on the highest point of the mountain.

The station is marked by the usual brass bolt stamped with the usual triangle and the number XXXIV A, the bolt being cemented in a large rock at the centre of the cairn. Two iron reference bolts were placed, one 6 feet north and the other 6 feet south of the geodetic point. Owing to the nature of the summit the bolts could not be placed in solid rock. The stone cairn erected measured 5 feet in diameter at the base and was 7 feet high.

REVELSTOKE.—At Revelstoke the longitude station of the Geodetic Survey was located, and the angle at that point between Mackenzie and Begbie was read. The longitude pier is a concrete pier measuring 20 inches by 27 inches, and about 3 feet high. It is situated on the top of the hill at the rear of the Revelstoke hotel, and is distant 1066·7 feet south and 2181·1 feet east of the southeast corner of Government street and Victoria road.

CARNES.—Carnes station is situated on a mountain lying near the head of the north branch of Carnes creek. It may be reached from Revelstoke by proceeding up the Columbia river trail to Carnes creek, then up this creek by a branch trail to the forks, which are about 4 miles from the mouth. Here the trail again divides, one branch leading to some deserted mining claims, near timber-line on the mountain between the forks of the creek. Following this branch to timber-line it is necessary to take a light camp to the next valley to the north before attempting to climb Carnes mountain. From this valley the station can be reached in from four to six hours according to the condition of the snow and ice.

The station is marked by the usual brass bolt stamped with the customary triangle, and the letters T.S. The apex of the triangle faces north, and is at the centre of the bolt. Three iron reference bolts are cemented in holes drilled in the rock, their distances and bearings from the geodetic point being: Bolt "I," distance 9·1 feet, bearing 41° 05′; bolt "II," distance 6·85 feet, bearing 113° 40′; bolt "III," distance 9·3 feet, bearing 201° 40′. The stone cairn over the geodetic point is 5 feet in diameter at the base and 8 feet high.

CORNICE.—Cornice station is situated on the east side of the north fork of the Illecillewaet river. It may be reached from Albert Canyon railway station by following the old wagon road to the Waverly and Tangier mines for about 15 miles to some open meadows known as "The Farm." From here the cairn is visible, and can be easily reached in from four to five hours.

The station is marked by the usual brass bolt cemented in the rock and stamped with a triangle and the letters T.S. The apex of the triangle, which faces north and is at the centre of the head of the bolt, is the geodetic point. Three iron reference bolts were cemented in the rock, their distances and bearings from the geodetic point being: Bolt "I," distance 14·15 feet, bearing 333° 00′; bolt "II," distance 8·84 feet, bearing 62° 00′; bolt "III," distance 5·4 feet, bearing 280° 30′. The cairn over the geodetic point is 5 feet diameter and 8 feet high.

COPELAND.—Copeland station is situated on mount Copeland, which is about 12 miles northwest of the town of Revelstoke, between two forks of the Jordan river. It may be reached by following the old trail up the Jordan river to the third fork, about 15 miles from Revelstoke. Here the trail follows the north side of the west branch, locally known as Goose creek. Following this trail for about 3 miles a light camp may be taken to a small amphitheatre a little to the south, and about 1,500 feet above the valley. From this camp the signal may be reached in two or three hours. The last 5 miles of the trails mentioned are impassable for horses.

Looking south east from near Carnes station.

A snowfield on Carnes mountain.

The station is situated about 6 feet west of the highest point of the mountain. It is marked by the usual brass bolt stamped in the usual manner with a triangle having its apex at the centre of the head of the bolt, and facing north, and with the number XXXVII. Three iron reference bolts were stamped and placed at distances and bearings from the geodetic point as follows: Bolt "I," distance 4·75 feet, bearing 98° 00′; bolt "II," distance 7·1 feet, bearing 185° 00′; bolt "III," distance 7·0 feet, bearing 323° 30′; bolts "I" and "II" are in solid rock. The brass bolt and bolt "III" are in large rocks which do not appear likely to move. The cairn over the brass bolt is 5 feet in diameter at the base and 7 feet high.

BEGBIE.—Begbie station is situated on the highest easterly corner of mount Begbie about 8 miles south of Revelstoke. It is most easily reached by the wagon road and trail to Fleming's ranch on the west side of the Columbia river. The base of the mountain is about 2 miles farther on.

The station is marked by the usual brass bolt stamped in the usual manner. Three iron reference marks stamped "II," "III," and "IIII" were placed, each being 6 feet distant and bearing east, south, and west, repectively, from the geodetic point. The stone cairn is 5 feet in diameter at the base and 8 feet high.

GRIFFIN.—Griffin station is on the highest point of mount Griffin about 4 miles west of Three Valley station, from which point it may be reached without difficulty. The mountain is not visible from the railroad, being hidden by a slightly lower intervening ridge.

The station is marked by the usual brass bolt stamped with the usual triangle and the number XXXIX. Two iron reference bolts were placed, one 18 feet north and the other 13·45 feet south of the geodetic point. All bolts are cemented in the solid rock. The cairn over the geodetic point is 5 feet diameter at the base and 9 feet high.

CRANBERRY.—Cranberry station is situated on a mountain about 11 miles southwest of Wigwam railway station. It may be reached by crossing the Columbia river at Wigwam, and passing over the divide about 500 feet high between the Columbia river and the bend in Cranberry creek where it turns south. The left bank of the creek is then followed upstream to the first large creek coming in from the west; Cranberry peak lies on the south side of this branch about 5 miles up from its mouth. The peak is not difficult to climb when it is reached, but there are no trails leading to it, and the country is very rough.

The station is marked by the usual brass bolt stamped with the usual triangle and the letters T.S., the apex of the triangle being as usual at the centre of the bolt, and facing north. The three iron reference bolts were placed at distances and bearings from the geodetic point as follows: Bolt "I," distance 10·2 feet, bearing 138° 00′; bolt "II," distance 18·05 feet, bearing 201° 45′; bolt "III," distance 11·8 feet, bearing 31° 45′. All bolts were cemented in large rocks which appeared unlikely to move. The stone cairn built over the geodetic point is 7 feet high.

MABEL.—Mabel mountain is situated on the east side of Mabel lake, about 30 miles from Enderby. It may be reached by following the wagon road from Enderby to the lake, and then crossing to the mouth of Tsausiu- creek (locally known as Cottonwood creek). From here an old Indian trail leads to the summit of the mountain.

The station is on the highest northerly point of the mountain overlooking Mabel lake. It is marked by the usual brass bolt stamped in the usual manner with a triangle and the number XLI. Reference bolts were marked and cemented in solid rock, their distances and bearings from the geodetic point being as follows: Bolt "I," distance 4·4 feet, bearing 4° 32′; bolt "II," distance 11·3 feet, bearing 71° 07′; bolt "III," distance 11·2 feet, bearing 212° 38′; bolt "IIII," distance 10·5 feet, bearing 293° 18′. Above the brass bolt, the trunk of a tree 9 feet high and 18 inches diameter at the top was securely placed.

MARA.—Mara signal can be most easily reached from Mara station on the Okanagan branch of the Canadian Pacific railway. It is situated on the Hunter range about 10 miles northeast of the railway station. From behind Mr. Blurton's ranch an old Indian trail leads to the summit of the ridge, and then turns northerly towards Griffin mountain.

The station is not situated on the highest point of the range, but on a slightly lower ridge about a mile to the southwest. It is marked by the usual brass bolt stamped with the usual triangle and the number XLII. Four iron reference bolts were marked and placed at distances and bearings from the geodetic point as follows: Bolt "I," distance 6·0 feet, bearing 0° 00′; bolt "II," distance 6·0 feet, bearing 90° 00′; bolt "III," distance 6·0 feet, bearing 180° 00′; bolt "IIII," distance 9·0 feet, bearing 270° 00′. All the bolts are cemented in solid rock. The cairn erected over the brass bolt is 6 feet diameter at the base and 9 feet high.

QUEEST.—Queest mountain consists of a long ridge rising just to the edge of timberline, and is situated about 4 or 5 miles northerly from Malakwa railway station.

The station is on the southwest part of the ridge, and is marked by the usual brass bolt stamped with a triangle and the letters T.S. Four iron reference bolts were marked and placed at distances and bearings from the geodetic point as follows: Bolt "I," distance 6·95 feet, bearing 59° 15′; bolt "II," distance 5·0 feet, bearing 199° 00′; bolt "III," distance 6·74 feet, bearing 264° 10′; bolt "IIII," distance 32·4 feet, bearing 325° 18′. All the bolts are cemented in the solid rock. The stone cairn over the geodetic point is 5 feet diameter at the base and 9 feet high.

BASTION.—Bastion signal is situated on a shoulder of the Bastion mountains about 5 miles west of Sicamous Junction. The station is marked by the usual brass bolt stamped with a triangle and the letters T.S. Reference bolts were placed at distances and bearings from the geodetic point as follows: Bolt "II," distance 5·55 feet, bearing 59° 50′; bolt "III," distance 9·15 feet, bearing 170° 30′; bolt "IIII," distance 7·0 feet, bearing 272° 00′. All bolts are cemented in the solid rock. Bolt "II" is the shell of an old cartridge, the copper top

projecting slightly above the cement. Over the geodetic point a wooden signal was erected, the apex of the drum being 7·6 feet above the brass bolt.

GRANITE.—Granite signal is situated near the summit of Granite mountain, about 4 miles northwest of Salmon Arm. The station is marked by the usual brass bolt stamped with the usual triangle and with the letters T.S. Four iron reference bolts were marked and placed at distances and bearings from the geodetic point as follows: Bolt "I," distance 9·1 feet, bearing 11° 55′; bolt "II," distance 10·15 feet, bearing 106° 00′; bolt "III," distance 12·90 feet, bearing 167° 00′; bolt "IIII," distance 6·70 feet, bearing 243° 00′. All bolts are cemented in the solid rock. Over the geodetic point a wooden signal was erected, the apex of the drum of the signal being 9 feet above the ground.

IDA.—Ida station is situated on a shoulder of mount Ida lying to the north of the main eastern part of the mountain, and about 200 feet lower than its highest point. It is only a short distance southeast of Salmon Arm railway station.

The station is marked by the usual brass bolt stamped with the customary triangle and the letters T.S. Three reference bolts were placed, their distances and bearings from the geodetic point being as follows: Bolt "I," distance 8·85 feet, bearing 343° 00′; bolt "II," distance 7·85 feet, bearing 87° 45′; bolt "III," distance 12·70 feet, bearing 195° 00′. All the bolts are cemented in the solid rock. Over the brass bolt a wooden signal was erected, the apex of the drum being 6·7 feet above the ground.

SUGARLOAF.—Sugarloaf station is situated on a bald hill about 6 miles north of Enderby, and 1,500 feet above the valley. It may be easily reached from Enderby by wagon roads leading to farms at the base.

The station is marked by the usual brass bolt stamped with the usual triangle and the letter "E." Three iron reference bolts were marked and placed at distances and bearings from the geodetic point as follows: Bolt "I," distance 12·3 feet, bearing 137° 35′; bolt "II," distance 12·2 feet, bearing 232° 55′; bolt "III," distance 4·7 feet, bearing 303° 40′. All bolts are cemented in the solid rock. Over the geodetic point a wooden signal with a cotton drum was erected, the apex of the drum being 5·5 feet above the ground.

ARMSTRONG.—Armstrong station was established on a burnt ridge nearly a mile south of the south limit of the Railway Belt and about 6 miles east of Armstrong railway station on the Okanagan branch of the Canadian Pacific railway. It is marked only by a cairn.

SALMON ARM BASE.—The *southwest end* of Salmon Arm base is situated in the southwest quarter of section 5, township 20, range 10, west of the sixth meridian.

The end of the base is marked by the usual brass bolt stamped with a cross and the letters T.S. One of the lines of the cross is in the direction of the base line and the other is at right angles to it. The point of intersection of these two lines is the end of the base. Four iron reference bolts were placed, each distant 6 feet and bearing due north, east, south, and west, respectively, from the geodetic point. All the bolts were placed in cement, the top of the brass

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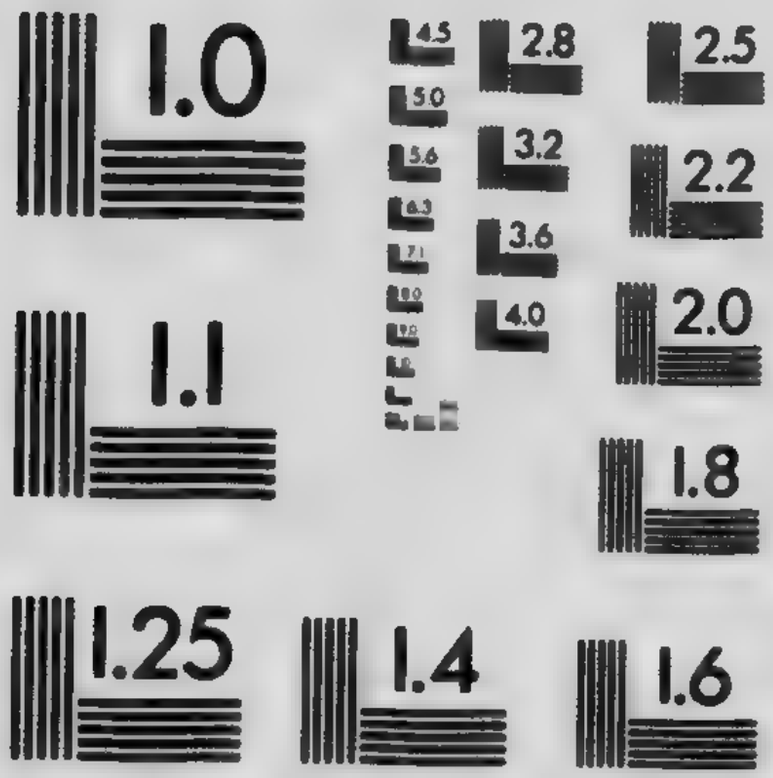

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bolt being 3·5 feet below the surface of the ground and the tops of the other bolts being about 2·5 feet below the surface.

According to ties made in the field, this end of the base is 14·92 chains west and 22·94 chains north of the middle of the south boundary of section 5, and 25·57 chains east and 23·00 chains north of the southwest corner of the same section.

The northeast end of the Salmon Arm base lies in the southwest quarter of section 24, township 20, range 10, west of the sixth meridian. It is about one mile northeast of the Salmon Arm railway station.

The end of the base is marked by the usual brass bolt stamped with a cross and the letters T.S. One line of the cross is in the direction of the base and the other at right angles to it, the intersection denoting the geodetic point. Four iron reference bolts were placed, each distant 6 feet and bearing due north, east, south, and west, respectively, from the geodetic point. All bolts were placed in cement, the top of the brass bolt being 3·5 feet below the surface of the ground and the tops of the other bolts about 2·5 feet below the surface.

As all the Dominion lands system posts along the east side of section 23 are missing, the end was connected by a traverse to the quarter-section post at the centre of section 24. With reference to this post the end lies 21·91 chains west and 4·56 chains south.

APPENDIX I.

Connection of Triangulation to Fifth Meridian.

In 1914 the triangulation was extended eastward by Mr. Bridgland to the Fifth meridian. This work necessitated the occupation and marking of nineteen stations. The old stations established by Mr. Drewry were used so that no reconnaissance survey was needed. Most of these stations were still in existence although the exact position of the geodetic point was in many cases doubtful; a few of the stations were entirely lost and had to be re-established.

Mr. Bridgland with his experience and natural ability as a mountain climber was able to occupy the nineteen stations in less than two months. In the angle observing, the same instrument and methods were used as are described in the foregoing pages. The lengths, latitudes and longitudes (see Appendix II) were carried through from the triangulation of the railway belt, the junction line being the well defined line C to King. The position of Storm as determined by Mr. Carson in 1907 under adverse conditions was not accepted, and Mr. Bridgland was instructed to make special efforts to overcome the many obstacles to accurate work presented by the very long sides of the larger triangles. For the twenty triangles of this connection, the average error of closing is 2·″5 and the average angle correction 0·″9.

Azimuth observations were taken at five stations. The observed azimuth in each case exceeded the computed azimuth as carried through from the western end of the net, by 2″ at Fifth meridian station, 7″ at Brushy Ridge, 14″ at Beaupre Hill, 16″ at Storm and 16″ at King. What part of this discrepancy may be due to local deflection and what part to a twist in the triangulation is problematical. It would appear, however, from all results that there is some twist to the southward going west from the Fifth meridian to the Rocky mountains, and about an equal twist to the northward going west over the railway belt triangulation. It is not of such extent, however, as would impair the value of the triangulation and the degree of refinement of the work does not call for any adjustment.

The positions of the triangulation stations in a theoretical Dominion lands system have been computed from the latitudes and longitudes, corrected as explained in Appendix II. These positions are given in the table on page 72. As stated on page 46, the computed positions of the triangulation stations must not be taken as the actual distances of triangulation points from posts which have been already established. In most cases where a triangulation station is situated in country already subdivided, a tie has been made between a Dominion lands system post in the vicinity and the triangulation. The table on page 73 gives the errors of survey of these posts.

A description of the location and marking of the triangulation stations is appended.

Station.	Latitude.			Longitude.			Azimuth.			Back Azimuth.			To Station.	Distance.	Logarithm.
	°	′	″	°	′	″	°	′	″	°	′	″		Metres	
Fifth Mer. Stn.	51	02	56·95	114	00	17·80	279	37	18	99	25	21	Brushy	18191·0	4·2598577
							309	24	45	129	20	03	Nose	9148·1	3·9613311
Nose	51	06	04·75	114	06	21·04	129	20	03	309	24	45	Fifth Mer. Stn.	9148·1	3·9613311
							255	38	00	75	30	46	Brushy	11214·3	4·0497707
							306	37	44	126	32	06	Spy	10502·7	4·0213026
Brushy	51	04	34·34	114	15	39·06	254	40	52	74	27	32	Sarcee	20781·5	4·3176769
							318	20	49	138	12	42	Cochrane	18291·4	4·2622470
							14	56	26	194	58	02	Spy	9370·7	3·9717701
							75	30	46	255	38	00	Nose	11214·3	4·0497707
							99	25	21	279	37	18	Fifth Mer. Stn.	18191·0	4·2598577
Spy	51	09	27·29	114	13	34·75	126	32	06	306	37	44	Nose	10302·7	4·0213026
							194	58	02	14	56	26	Brushy	9370·7	3·9717701
							237	06	02	56	51	04	Sarcee	26757·1	4·4274385
							287	35	34	107	25	49	Cochrane	15285·4	4·1842775
Cochrane	51	11	56·12	114	26	05·17	107	25	49	287	35	34	Spy	15285·4	4·1842775
							138	12	42	318	20	49	Brushy	18291·4	4·2622470
							202	14	23	22	09	10	Sarcee	20717·0	4·3163279
							293	56	31	113	44	50	Beaupre	19082·9	4·2806437
Sarcee	51	01	35·41	114	32	47·51	291	17	38	111	02	17	Chiniki	24721·3	4·3930712
							340	17	11	160	10	43	Beaupre	28580·4	4·4560679
							22	09	10	202	14	23	Cochrane	20717·0	4·3163279
							56	51	04	237	06	02	Spy	26757·1	4·4274385
							74	27	32	254	40	52	Brushy	20781·5	4·3176769
Beaupre	51	16	05·75	114	41	04·77	113	44	50	293	56	31	Cochrane	19082·9	4·2806437
							160	10	43	340	17	11	Sarcee	28580·4	4·4560679
							216	39	15	36	30	20	Chiniki	22377·8	4·3498176
							278	20	50	98	09	04	Ghost	17733·5	4·2487937
Chiniki	51	06	24·26	114	52	31·44	240	15	32	59	57	21	Wind	31539·8	4·4988589
							304	56	15	124	37	05	Minnewanka	34887·7	4·5426718
							348	19	26	168	16	36	Ghost	20949·6	4·3211765
							36	30	20	216	39	15	Beaupre	22377·8	4·3498176
							111	02	17	291	17	38	Sarcee	24721·3	4·3930712
Ghost	51	17	28·08	114	56	10·23									

Ghost	51	17	28·08	114	56	10·23	98	09	04	278	20	50	Beaupre	17733·5	4·2487937
							168	16	36	348	19	26	Chiniki	20949·6	4·3211765
							212	34	26	32	19	04	Wind	42935·2	4·6328138
							268	41	28	88	25	07	Minnewanka	24366·3	4·3867893
Minnewanka	51	17	08·20	115	17	07·19	88	25	07	268	41	28	Ghost	24366·3	4·3867893
							124	37	05	304	56	15	Chiniki	34887·7	4·5426718
							177	43	40	357	44	36	Wind	35646·4	4·5520159
							252	13	16	72	00	08	Cascade	20584·1	4·3135315
Wind	50	57	55·61	115	15	54·77	283	04	15	102	44	08	Fatigue	31077·9	4·4924514
							324	23	51	144	09	49	Cascade	36083·6	4·5573103
							357	44	36	177	43	40	Minnewanka	35646·4	4·5520159
							32	19	04	212	34	26	Ghost	42935·2	4·6328138
							59	57	21	240	15	32	Chiniki	31539·8	4·4988589
Cascade	51	13	43·60	115	33	57·35	72	00	08	252	13	16	Minnewanka	20584·1	4·3135315
							144	09	49	324	23	51	Wind	36083·6	4·5573103
							202	19	16	22	13	10	Fatigue	24158·1	4·3830620
							265	50	13	85	29	34	Storm	30938·7	4·4905020
							315	27	00	135	12	08	Bonnet	31470·4	4·4979023
Fatigue	51	01	40·18	115	41	48·15	312	43	56	132	29	25	Storm	29566·6	4·4708013
							22	13	10	202	19	16	Cascade	24158 1	4·3830620
							102	44	08	283	04	15	Wind	310;7·9	4·4924514
Storm	51	12	27·92	116	00	26·88	249	54	36	69	29	29	C	40093·5	4·6030736
							288	25	28	107	55	19	King	47317·6	4·6750230
							336	25	26	156	14	01	Hector	42228·3	4·6256033
							19	14	34	199	20	23	Bonnet	26188·5	4·4181100
							85	29	34	265	50	13	Cascade	30938·7	4·4905020
							132	29	25	312	43	56	Fatigue	29566·6	4·4708013
Bonnet	51	25	47·75	115	53	00·12	135	12	08	315	27	00	Cascade	31470·4	4·4979023
							199	20	23	19	14	34	Storm	26188·5	4·4181100
							298	48	27	118	31	11	Hector	29098·1	4·4638650
Hector	51	33	19·38	116	15	03·53	118	31	11	298	48	27	Bonnet	29098·1	4·4638650
							156	14	01	336	25	26	Storm	42228·3	4·6256033
							229	30	42	49	11	53	King	36717·4	4·5648713
							266	12	43	85	56	19	McArthur	24268·0	4·3850344

Positions of Triangulation Stations in Dominion Lands System.

West of Fifth Meridian.

Station.	Section, Township and Range in which Station lies.			Distance from Station to Northeast Corner of Section.	
	Sec.	Tp.	R.	Northing	Easting
Fifth Mer. Stn.	13	24	1	16·74	0·00
Nose	5	25	1	50·30	27·43
Brushy	30	24	2	28·17	0·32
Spy	28	25	2	61·12	41·98
Cochrane	12	26	4	73·32	38·98
Sarcee	7	24	4	61·08	23·37
Beaupre	31	26	5	11·84	18·37
Chiniki	2	25	7	20·29	34·78
Ghost	9	27	7	46·39	60·16
Minnewanka	12	27	10	76·81	52·05
Wind	24	23	10	76·72	15·54
Cascade	23	26	12	69·24	9·87
Fatigue	12	24	13	53·69	60·47
Storm	10	26	15	24·57	8·74
Bonnet	27	28	14	3·66	13·11
Hector	7	30	16	33·66	68·65

Comparison of Actual with Theoretic Positions of some Dominion Lands Survey Posts.

Station.	Point of D.L. System to which tie is made.	Distance from Triangulation Station to D.L. System Post.				Errors of D.L. System.	
		By actual measurement.		As computed for a theoretical D.L. system.			
		Latitudes.	Departures.	Latitudes.	Departures.	Latitudes.	Departures.
		Chains.	Chains.	Chains.	Chains.	Chains.	Chains.
Fifth Mer. Stn.	Section post at northeast corner of sec. 13, tp. 24-1-5	N 17·25	0·00	N 16·74	0·00	N 0·51	0·00
Brushy	Quarter post at middle of east boundary of sec. 30, tp. 24-2-5	S 11·05	E 0·38	S 11·83	E 0·32	N 0·78	E 0·06
Spy	Section post at northeast corner of sec. 20, tp. 25-2-5	S 20·01	W 38·81	S 19·88	W 38·92	S 0·13	E 0·11
Cochrane	Section post at northeast corner of sec. 2, tp. 26-4-5	S 6·66	W 41·44	S 6·68	W 41·84	N 0·02	E 0·40
Chiniki	Section post at northeast corner of sec. 34, tp. 24-7-5	S 59·96	W 45·60	S 60·71	W 46·22	N 0·75	E 0·62
Cascade	Quarter post at middle of north boundary of sec. 1, tp. 26-12-5	S 163·71	E 48·21	S 171·76	E 50·77	N 8·05	W 2·56
Storm	Section post at northeast corner of sec. 1, tp. 27-15-5	N 435·76	E 119″·60*	N 427·53	E 122″·99*	N 8·23	W 3·27

*These longitude differences are given in seconds of arc.

Description of Stations.

Fifth Meridian Station.—The Fifth Meridian station is situated on the Fifth meridian, 17·25 chains south of the northeast corner of section 13, township 24. It is marked by a brass bolt placed in cement, the top of the bolt being 2·5 feet beneath the surface of the ground. The bolt is half an inch in diameter with a head one inch square and is six inches long. The head is marked with the number "I" and a triangle. The vertex of the triangle at the centre of the head of the bolt is the geodetic point. Two iron reference posts were placed, one six feet south and the other six feet north. The bolt to the south is marked "T.S.I." on south face, and "N VI Ft" on its north face. The bolt to the north is marked "T.S.I." on its north face and "S VI Ft" on its south face. A wooden hub driven flush with the ground and marked at centre by a nail is left as a surface mark.

Nose Hill.—Nose Hill station is situated on Nose Hill, about five miles northwest of Calgary. It is marked by a brass bolt placed in cement, the top of the bolt being two feet beneath the surface of the ground. The bolt is half an inch in diameter and six inches long. The head is one inch square and is marked with the number "II" in Roman numerals, and a triangle the apex of which, at the centre of the head, indicates the geodetic point. A reference iron post is placed six feet south; it is marked "T.S.II" on its south, and "N VI Ft" on its north face. A second reference point consists of an iron bolt cemented in a hole drilled in a large boulder. This bolt is 17·4 feet from the station and the azimuth from the station to the bolt is 131° 20′.

Brushy Ridge.—Brushy Ridge station is situated about 8 miles west of Calgary near the east boundary of section 30, township 24, range 2. It lies in the highest part of the corral of Mr. John Crews. It is marked by the usual brass bolt placed in cement, the top of the bolt being 2·5 feet beneath the surface of the ground. The top of the bolt is stamped with the number "III" in Roman numerals, and a triangle, the apex of which is the geodetic point. As a reference mark an iron post was planted six feet north and driven flush with the ground. This post is marked "T.S. III" on its north side and "S VI Ft" on its south side. For a second reference mark a nail was driven into the corner of one of the buildings about two feet above the ground and marked with arrows. This nail is distant 192·3 feet at a bearing of 242° 53′ from the geodetic point.

The station is distant 729·9 feet from the quarter post on the middle of the east boundary of section 30, township 24, range 2, and the bearing of the quarter post is 178° 01′.

Spy Hill.—Spy Hill station is situated on the highest point of a hill near the south side of section 28, township 25, range 2. The highest point is at the northerly end of the hill. The station is marked by the usual brass bolt, the head of which is stamped with number "IV" and a triangle. The bolt is placed in cement, the top being two feet beneath the surface of the ground. An iron post as a reference mark was six feet north; it is marked "T.S. IV" on its north face and "S VI Ft" on its south face.

The station has been tied to the northeast corner of section 20, township 25, range 2; the distance and bearing of the section corner from the station being 2882·0 feet and 242° 44′.

Cochrane.—Cochrane station is situated on [illegible]igh plateau in section 1, township 26, range 4, about one mile northeast o[illegible]ochrane. It is marked by the usual brass bolt placed in cement. The head of the bolt is 2·5 feet beneath the surface of the ground and is stamped with the number "V" and a triangle. An iron post is placed as a reference mark six feet south of the station; it is marked "T.S.V" on its south face, and "N VI Ft" on its north face. From the station to the northeast corner of section 35, township 25, range 4, the distance is 2770·0 feet and the bearing 260° 52′.

Sarcee Butte.—Sarcee Butte station is situated at the northerly end of a brushy ridge in section 7, township 24, range 4. It is marked by the usual brass bolt set in cement which rests upon solid rock. The head of the bolt is two feet beneath the surface of the ground; it is stamped with the number "VI" and a triangle. As reference marks two iron bolts are cemented in holes drilled in solid rock. They are distant 34·7 feet and 27·1 feet from the station, and their bearings from the station are 207° 56′ and 268° 07′ respectively.

Beaupre Hill.—Beaupre Hill is situated in section 31, township 26, range 5. The station is on a long ridge running in a northerly and southerly direction. About a mile from the south end there is a gap in the ridge through which a small stream flows westerly. The station lies a short distance north of this gap on the highest part of the southerly end of the ridge. It may be reached easily from Cochrane by following the Banff road for about ten miles west and then taking a trail to the north which runs along the base of the hill on the west side.

The station is marked by an iron post three feet long. The post is stamped on one side with a triangle and the top is about six inches above the ground. As reference marks two iron bolts stamped "I" and "II" respectively were cemented in holes in large and apparently solid rocks. Their bearings and distances from the geodetic point are as follows: Bolt "I," distance 5·4 feet, bearing [illegible]: Bolt "II," distance 3·2 feet, bearing 111° 35′.

C[illegible]*iniki* station is situated on the westerly point of a high hill about [illegible]s south of Morley, from which railway station it may be easily reache[illegible]

The station is marked by an iron post three feet long, driven into the ground to within three inches of the top. It is stamped with a triangle and the letters "T.S.". Two iron reference posts were placed, one six feet east and the other six feet west of the station.

Ghost.—Ghost station is situated on a high foothill north of the south branch of Ghost river. It is about ten miles from Morley and may be reached by following an old lumber road from that railway station. It may also be reached by a wagon road from Cochrane.

The station lies about five chains north of the south end of the ridge, the south end being a little higher than the station. It is marked by an iron post three feet long driven into the ground to within three inches of the top. The post is stamped on one side with a triangle and the letters "T.S." As reference marks were placed two iron posts, one six feet north and the other six feet east of the station.

Minnewanka.—Minnewanka station is on the western arête of mount Costigan on a point about two hundred feet below the summit of the mountain at an approximate elevation of 9,560 feet above sea level. It lies about three miles due north of the east end of Lake Minnewanka. A good wagon road leads from Banff to the west end of the lake and from there a pack trail runs to the east end. The station may be reached by crossing the ridge just north of the end of the lake and following up the small stream on the other side for about two miles. A branch coming in from the east is then followed for about a quarter of a mile and then a long shale slope leads to the arête and thence to the signal. The stream followed flows into the flat a short distance east of the east end of lake Minnewanka. It may be possible to follow up this stream, but as the lower end appeared to be cañon it was thought advisable to cross the ridge and enter the stream higher up.

The station is marked by the usual brass bolt stamped with the letters "T.S." and a triangle, the apex of the triangle facing north. It is further marked by three iron reference bolts marked I, II and III respectively and placed as follows: Bolt "I," distance 5·7 feet, bearing 157° 40′; Bolt "II," distance 7·4 feet, bearing 321° 42′; Bolt "III," distance 5·3 feet, bearing 35° 30′. The brass bolt was cemented as securely as possible in the rocks at the centre of the cairn. The reference bolts were cemented in holes drilled in solid rock.

Over the brass bolt a stone cairn about 4 feet in diameter at the base and 5 feet high was built.

Wind.—Wind station is situated on the second peak of Wind mountain from the north, about 10,100 feet above sea level. It lies about eighteen miles southeast of Banff, and may be reached from that station by following the trail up the Spray river or from Canmore by way of the White Man's pass. The mountain may be most easily climbed from a camp at the upper end of the lower Spray lake, twenty miles by trail from Banff. From here a small valley may be seen between the mountains to the east. By following this valley to near its head the base of the southern slopes of the mountain may be reached and these offer no difficulty. The signal may be reached from the lake in from four to five hours.

The station is marked by a brass bolt with the head stamped with the letters "T.S." and a triangle. The apex of the triangle is at the centre of the bolt and faces north. The station is further marked by three iron reference bolts stamped I, II and III respectively and placed at distances and bearings from the station as follows: Bolt "I," distance 16·1 feet, bearing 322° 00′. Bolt "II," distance 11·8 feet, bearing 167° 00′. Bolt "III," distance 26·0 feet, bearing 225° 40′. The brass bolt was cemented as securely as possible in the rocks at the centre of the cairn. The reference bolts were cemented in holes drilled in solid rock. Above the brass bolt a stone cairn 6·1 feet high was built.

Notes regarding visiting Wind station and Fatigue station.—If it is necessary to visit both Wind station and Fatigue station, an interesting trip may be made by travelling around by mount Assiniboine. For travelling with a pack train the following notes give moves to be made on trail without any regard to climb-

ing. It is also assumed that the horses are in good condition and not heavily packed.

First day.—Banff to head of lower Spray lake, about twenty miles. Wind mountain and station may be easily reached from here.

Second day.—Move to head of Spray valley and cross divide to British Columbia side. Camp a short distance north of mount Assiniboine. This is a long day for horses.

Third day.—Do not go to base of mount Assiniboine. Follow trail leading northerly and eventually into a branch of the Simpson river. This valley is dry for a short distance. About half a mile below where water is first found there is an old teepee and a draw entering from the east. Follow trail up to the summit and camp as soon as convenient after reaching the summit. Fatigue mountain and station may be reached in from two to three hours from any place on the southern part of the summit. This is also a hard day for horses.

Fourth day.—Follow the Healy creek summit northerly till about four miles from where the trail first reached it. Then follow the trail down Healy creek and thence to Banff.

This trip requires at least four days on the trail, and unless the horses are in good condition and not too heavily packed should require longer. The four days do not allow for any delay in finding trails or in locating mountains. On the other hand Banff to Spray lake and return means at least two days and Banff to the base of Fatigue mountain would mean two days on the trip out and one day back, these trips being equally hard if not harder on horses than the round trip by Assiniboine.

Cascade.—Cascade station is situated on the summit of Cascade mountain about four miles north of Banff. The mountain may be climbed very easily by following Fortymile creek for about two miles and then ascending the westerly slopes of the mountain. Its altitude is about 9,826 feet above sea level.

The station is marked by the usual brass bolt stamped with the letters "T.S." and a triangle, the apex of the triangle toward the north. It is further marked by four iron reference bolts stamped I, II, III and IIII respectively and situated from the geodetic point as follows: Bolt "I," distance 7·6 feet, bearing 352° 35′; Bolt "II," distance 11·0 feet, bearing 104° 30′; Bolt "III," distance 8·7 feet, bearing 157° 10′; Bolt "IIII," distance 15·9 feet, bearing 181° 25′. The brass bolt is cemented as securely as possible in the rocks at the centre of the cairn. The reference bolts are cemented in holes drilled in the solid rock. Over the brass bolt a stone cairn six feet in diameter at the base and 6·8 feet high was built.

Fatigue.—Fatigue station is on Fatigue mountain about twelve miles southwest of Banff. Its elevation is about 9,700 feet above sea level. It may be reached from Banff by following the trail up the south branch of Healy creek to the summit and thence southeasterly along the summit for about four miles. The mountain then lies in the east and may be climbed in from two to three hours. The trip from Banff to the mountain requires two days, but it is possible to return in one day.

The signal is marked by the usual brass bolt stamped with the letters "T.S." and a triangle, the apex of the triangle facing north. It is further marked

by three iron reference bolts stamped I, II and III respectively and situated from the geodetic point as follows: Bolt "I," distance 23·2 feet, bearing 298° 45′; Bolt "II," distance 22·0 feet, bearing 107° 30′; Bolt "III," distance 9·3 feet, bearing 178° 24′. The brass bolt was cemented as firmly as possible in the rocks at the centre of the cairn. The reference bolts were cemented in holes drilled in solid rock. Above the brass bolt a stone cairn 7·1 feet high was erected.

Storm.—Storm station is on the summit of Storm mountain. The mountain is visible from Castle Mountain railway station, being about six miles distant in a southwesterly direction.

The route taken by Mr. Carson to Storm mountain was as follows: From Castle Mountain railway station, an old tote road was followed westerly up Bow river for nearly two miles, and the river then forded. Then by the Vermilion trail along the south fork of Vermilion creek to Vermilion pass, a distance of about eight miles from the railway. From a camp about half a mile south of the pass the ascent of Storm mountain was made up the valley of a small creek to timberline, and the steep snow covered south slope, reaching the broad summit after about five and a half hours climbing.

The station is marked as described on pages 56 and 57.

Bonnet.—Bonnet station is situated on Bonnet Peak in the northern part of township 28, range 14, west of the Fifth meridian. It lies near the head of Cascade creek, on the north side, and may be reached from Banff by going to Bankhead and then following the trail up Cascade creek to its head. A shorter route is to follow the trail leading under mount Edith and into the valley of Fortymile creek, thence to the head of Fortymile creek and down Sawback creek to its junction with Cascade creek. Here the trail turns sharply to the west and follows the west branch of Cascade creek to its head. Bonnet Peak then lies about three miles to the north and may be reached easily in about four hours. Its altitude is about 10,290 feet. This trip including the climb requires at least five days.

The station is marked by a brass bolt stamped with a triangle and the letters "T.S." Two iron reference bolts stamped I and II respectively, were cemented in the solid rock. Their positions from the geodetic point are as follows: Bolt "I," distance 8·8 feet, bearing 279° 38′; Bolt "II," distance 9·9 feet, bearing 59° 40′. Over the brass bolt a stone cairn six feet in diameter at the base and 8·2 feet high was built.

Hector.—Hector station is situated on a peak about 9,700 feet above sea level, about a mile south of mount Hector, on the east side of the Bow river. It may be climbed easily from any place on the Bow river trail, six to eight miles north of Laggan.

The station is marked by a brass bolt stamped with the letters "T.S." and a triangle, the apex of the triangle being at the centre of the bolt facing north. It is further marked by four iron reference bolts stamped I, II, III and IIII respectively, and situated from the geodetic point as follows: Bolt "I," distance 8·0 feet, bearing 293° 40′; Bolt "II," distance 12·2 feet, bearing 137° 20′; Bolt "III," distance 12·3 feet, bearing 211° 10′; Bolt "IIII," distance

6·8 feet, bearing 252° 30′. All bolts are cemented in solid rock. Over the brass bolt a stone cairn six feet diameter at the base and 7·5 feet high was built.

King.—King station is situated on the summit of mount King at the southerly end of the Van Horne range and distant about four miles in a northwest direction from Ottertail railway station.

King station can be reached from Field, B.C., by following the Ottertail waggon road down the south side of the Kicking Horse river to near the Emerald railway siding. Here a trail turns off into the Kicking Horse flats and follows the river about three miles to a ford which leads to a continuation of the trail up the Otterhead river to a logger's camp about three miles from the mouth of the stream. About three quarters of a mile above the shanty a small stream is tributary to the Otterhead. Following up this stream to its head and crossing a shoulder to the north the basin of Bear creek is reached. The remainder of the trip is up a steep ridge which makes an interesting climb. The summit is about fifty feet long east and west, but only a narrow ledge of rock north and south with a sheer drop of five hundred feet on the north side.

The station is marked as described on page 57.

APPENDIX II.

Latitudes and Longitudes.

As stated on page 15 the triangulation latitudes and longitudes were based upon latitude observations taken at Sugarloaf and Salmon Arm, and a longitude determination at Revelstoke. To compute the position which any triangulation point should occupy in a theoretic Dominion lands system we require to know its actual geodetic latitude and its longitude measured from the governing initial meridian. When the triangulation computations were first made, the distance of a point west of the Fifth meridian in longitude was estimated by carrying the computations eastward to a point on the Fifth meridian through old surveys. The longitude of the Fifth meridian as thus computed from the Revelstoke determination was found to be 114° 00′ 17″·45; consequently by subtracting this longitude from the computed longitude of any triangulation point we obtained the distance in longitude of that point west from the Fifth meridian.

For the latitudes, however, greater difficulties were met with. The connection of the triangulation to a point on the Fifth meridian was in this case of little value, since the Fifth meridian in this locality was established in the early survey days when, from several causes, such accurate surveys as are now required were not possible. For instance, it was known that the chainage along the Fifth meridian was not accurate so that posts on the Fifth meridian were not in their correct latitudes, and their errors of position were not known. The computed latitudes of the triangulation points therefore, based upon two latitude observations in the mountains, were considered as nearly accurate as could then be estimated.

Thus the latitudes and longitudes given in the tables of this book are based upon astronomical determinations which are undoubtedly influenced by local deflections of the vertical. Recent surveys have enabled us to make a close approximation to the corrections required to the triangulation figures to reduce them to a proper geodetic basis.

In 1914 Mr. Bridgland extended the triangulation eastward to the Fifth meridian by re-occupying the stations established by Mr. Drewry many years ago. The reduction of this triangulation showed that the longitude connection through the older surveys was in error by about 35 links in 100 miles, due principally to a discrepancy of about $\frac{1}{2000}$ between the lengths of the old triangulation and Mr. Bridgland's triangulation. There can be no doubt that this discrepancy is largely due to the incorrect length of the tape used by Mr. Drewry in the measurement of his base 27 years ago.

We now have a direct triangulation connection between the Revelstoke longitude station and the Fifth meridian. As computed from Revelstoke the

longitude of the Fifth meridian in township 24 is 114° 00′ 17″·8*, and the longitude of the Sixth meridian in the railway belt 118° 00′ 23″·7.* The Revelstoke longitude determination is undoubtedly affected by some large local deflection of the vertical. It is not necessary for us to know the magnitude of this deflection in order to compute the positions of the triangulation stations in the Dominion lands system; it is sufficient for our purpose that for points between the Fifth and Sixth meridians, by subtracting 114° 00′ 17″·8 from the longitudes given, we obtain the distances in longitude of the points west of the Fifth meridian and for points west of the Sixth meridian by subtracting 118° 00′ 23″·7 we obtain their distances in longitude west of the Sixth meridian.

A system of retracement surveys which has recently been found necessary over some of the very old surveys, was in 1915 extended westward to the Fifth meridian. These retracements provide us with the first reliable data upon which to estimate a correction to the triangulation latitudes, to reduce them to the same geodetic basis which governs the whole Dominion lands system. This correction is + 1″·38.

Having thus corrected the latitudes and longitudes, the positions of the triangulation points were computed by the method explained in the Supplement to the Manual.

As explained in the Supplement, allowance must be made for the fact that the Dominion lands surveys are not made at sea level. In longitude a mean elevation of 3,500 feet was taken for the country between the Fifth and Sixth meridians, and of 2,000 feet for the country west of the Sixth meridian. In latitude a mean elevation of 3,500 feet was taken.

When taking out latitudes from Table X of the Supplement, it should be remarked that this table is for the Third system of survey. For the railway belt the table must be adapted to the Fourth system of survey, by correcting the latitudes of the alternate section corners, viz., the northeast corners of sections 1, 13 and 25 in each township, by subtracting therefrom 0″·33 the equivalent in arc of 50 links. The widths of the quarter-sections as given in the last column must be increased by 50 links. West of the Sixth meridian the theoretic latitudes of all section corners must be increased by 13″·42 (20·62 chains) because of the northerly displacement of the Dominion lands system in the railway belt occurring at the Sixth meridian.

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*The longitude of the Fifth meridian in township 24, as computed through the triangulation from Revelstoke is 114° 00′ 17″·8. This value includes the large local deflection which evidently affects the Revelstoke longitude determination; it is not the true geodetic longitude of the Fifth meridian. Unfortunately we are at present unable to accurately determine the magnitude of the local deflection at Revelstoke, but an approximate estimate can be made:—

The geodetic longitude of the Fifth meridian in township 24, within two or three seconds, is 114° 00′ 01″·5. Hence with the same degree of approximation, all the longitudes given in the tables—based upon the Revelstoke longitude determination—may be reduced to geodetic by applying a correction of −16″·3.

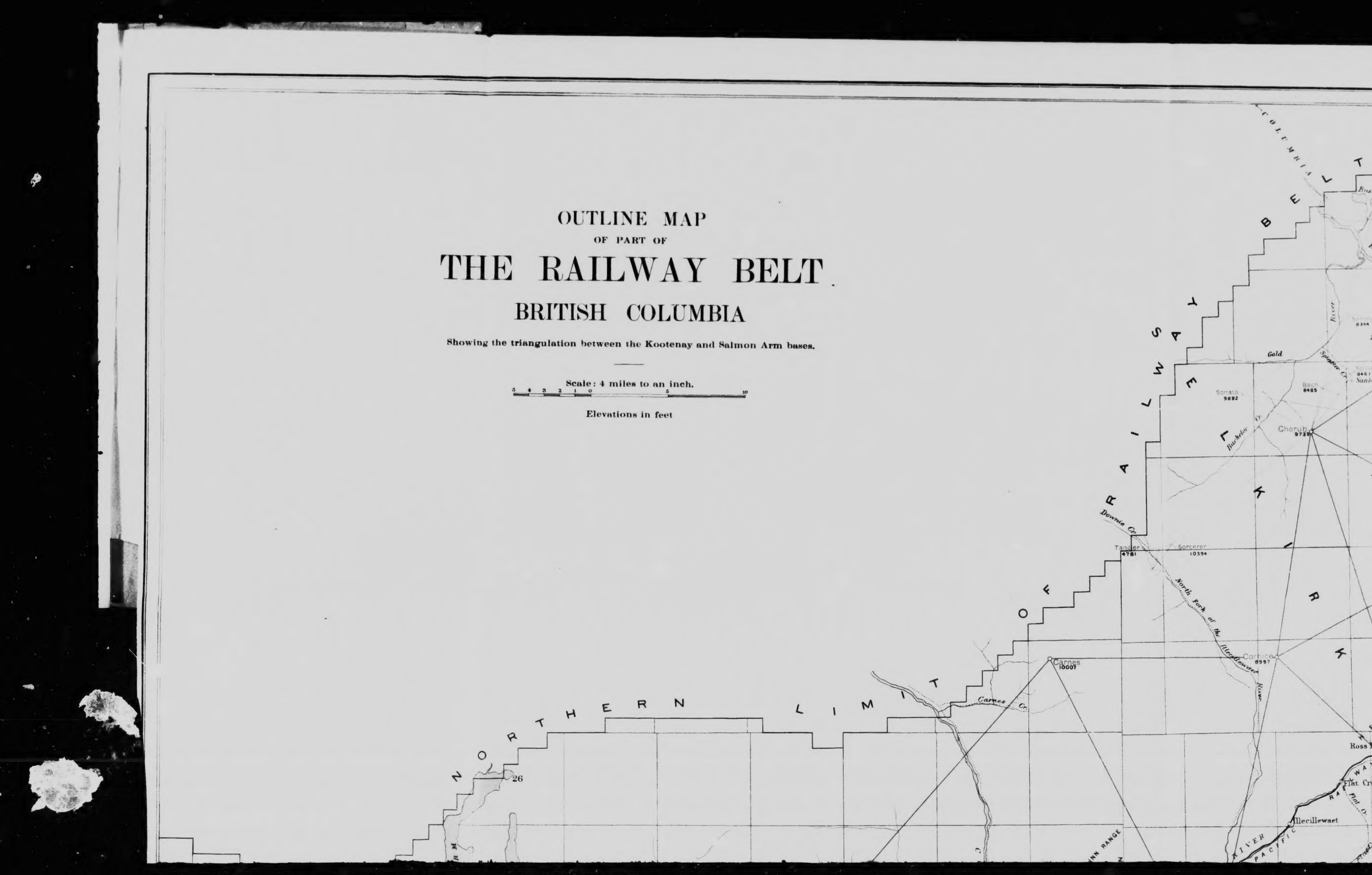
OUTLINE MAP
OF PART OF
THE RAILWAY BELT
BRITISH COLUMBIA

Showing the triangulation between the Kootenay and Salmon Arm bases.

Scale: 4 miles to an inch.

5 4 3 2 1 0 5 10

Elevations in feet



Boundary between the Provinces of Alberta and British Columbia

COLUMBIA

BELT

ROCKY MOUNTAINS

RAILWAY

PACIFIC

CANADIAN

NORTHERN

RAILWAY

KOOTENAY CENTRAL RAILWAY

RIVER

BLACKWATER

Bush 8197

Bush Lake

Val 2526

Yellow 8256

South Fork of Bush River

Bush River

Pack Trail from Donald to Big Bend and Tete Jaune Cache

32

31

30

29

28

27

26

25

Blackwater 8264

Blackwater L.

Blackwater Cr.

Waterhen Cr.

Ms Mummery 10909

Mummery Gr.

Bisquerry 9640

Laussedat 10035

Sentry 8344

Sentry River

Gold

Spinster 8467

Sunbeam L.

Spinster Cr.

Sonata 9892

Bacn 8485

Cupola 8678

Cherub 9739

Backdoor Cr.

Stemple Creek (North Br.)

Stemple Creek (South Br.)

THE ESPLANADE RGE

RANGE

Beavermouth 2425

Redgrave

Donald

Stemple Creek

Griffith 8892

Beavermouth

Quartz Cr.

Forde

Donald 6811

Sturdee

Cut Bank

Bear Creek

Moberly

BLAEBERRY

VAN HORNE RANGE

Porcupine Cr.

King 9488

Emerald

Horse River

Ottertail

Kicking Horse River

Downie Cr.

Tangier 4781

Sorcerer 10394

North Fork of the Illecillewaet River

Carnes 10007

Carnes Cr.

Cornice 8997

Hermit

Rogers Pass

Golden

Cloister

Glenogle

Nicholson

Palliser

Wapta

Leanchoil

Kapristo 8930

Canyon Cr.

Cheops 8506

Cambie

Glacier

Ross Peak 3606

Ross Peak

Abbott 8081

Mt Green 8860

Flat Creek

Mt Swanzy 9562

Bonney 10194

Illecillewaet

Flat Cr.

Beaver River

Loop Brook

Abraham River

Cecil 9982

North Fork 8587

Pick 6757

BALD MOUNTAIN

McArthur 9882

L. Duchesne

Kinnaird Pass

PRESIDENT RANGE

Yoho Pass

Emerald L.

Yoho River

Moris

HERMIT RANGE

SIR DONALD RANGE

BEAVER HILLS

DOGTOOTH

BEAVERFOOT

MOUNTAINS

COLUMBIA

Backdoor Cr.

Stemple Creek (North Br.)

Stemple Creek (South Br.)

Flat Cr.

Flat Creek

Loop Brook

Beaver River

Abraham River

Pinnacle Pass

Illecillewaet River

Downie

AUDAINN RANGE

NORTHERN LIMIT

SEYMOUR ARM
SHUSWAP LAKE
ASTEN ARM
SHUSWAP LAKE
SHUSWAP
EAGLE
BASTION MTS
SALMON ARM
SALMON ARM BASE
SALMON ARM
MARA LAKE
HUNTERS RANGE
MOUNTAINS
EAGLE PASS Mts
North York Eagle River
Jordan River
GOLDEN
COLUMBIA
CLACHNACUDAINN RANGE
MERIDIAN
SIXTH
ILLECILLEWAET
CANADIAN PACIFIC RAILWAY
ARROW LAKE BR. C.P.R.
MABEL LAKE
MABEL RANGE
RANGE
Upper Shuswap River
Cranberry Cr.
Kingfisher Cr.
Tsuius Cr.
SHUSWAP R.
SOUTHERN LIMIT
UPPER ARROW LAKE
Northeast Arm

Copeland 8472
Queest 4846
Craigellachie
Taft
Malakwa
Three Valley
Clanwilliam
Griffin 7082
Bowie
Solsqua
Notch Hill
Black Hill
Carlin
Bastion 4416
Sicamous (Jct.)
Annis
Fossett
Mowitch
Tappen
Granite 5014
Canoe
Mara 7261
Fly 5749
N. End 1167
Salmon Arm
S. End 1170
Mara
Ida 4934
Sugarloaf 2582
Grindrod
Mabel 7009
XXXIII 1524
REVELSTOKE
Greeley 3235
Twin Butte
Albert 9621
Laureta
Downie
Albert Canyon
Illecillewaet
Ross Peak
Flat Creek
Mackenzie 8073
Cartier 8563
Begbie 8963
Greenslide
Wigwam
Incomappleux 8781
8800
8317
Comaplix
8024
Cranberry 8832
Arrowhead
Cambo

1 2 3 4 5 6 7 8 9 10 11
19 20 21 22 23 24 25 26
27 28 29 1

Rogers Pass
Glacier
Ross Peak 8606
Cambie
Mt Green 8860
Mt Swanzy 7962
Flat Creek
Bonney 10194
Illecillewaet
Downie
Albert Canyon
Laureita
Albert 9621
Twin Butte
Greeley 7239
Mackenzie 8073
Carver 8563
Greenslide
Wigwam
Camborne
Incomappleux 8781
Comaplix
Arrowhead
Northeast Arm
Upper Arrow Lake
Lower Arrow Lake
Sroat 8024
Burnt Ridge 8317
Sable
Scott Cr
Cranberry Cr
Cranberry
Arrow Lake Br C P R
Illecillewaet River
Pacific Railway
Canadian Pacific Railway
Selkirk Mountains
Rogers Pass
Sir Donald Range
Bald Mountain
Battle Range
Main Battle Range
Clachnacudainn Range
Incomappleux River
Sixth Meridian
Fifth Meridian
Bald Mountain Pick 6797
North Fork 8887
Cecil Rup 8982
Ross Peak 8606
Mt Green 8860
Mt Swanzy 7962
Bonney 10194
Grand 10492
Grand City
Golden
Glenogle
Nicholson
Palliser
Kapristo 8930
Leanchil
Wapta
Columbia River
Kootenay Central Railway
Kootenay Central Railway Branch C P R
Moro
Carbonate Landing
Parson
Spillimacheen
Spillimacheen River
Byron 8851
Antlot 8850
Pole 5071
Moodie 4872
Moodie 2682
Moodie 7964
Moodie 8013
Hobbie Burns Cr
Goldstoke
Greeley
Twin Cr East
Greenslide Cr
Sixth Meridian
Fifth Meridian
Battle Range
Main Battle Range
Incomappleux River
Clachnacudainn Range
Arrow Lake Br C P R
Cranberry Cr
Cranberry
Sable
Scott Cr
Burnt Ridge 8317
Incomappleux 8781
Camborne
Comaplix
Sroat 8024
Arrowhead
Northeast Arm
Upper Arrow Lake
Lower Arrow Lake
Illecillewaet River
Pacific Railway
Canadian Pacific Railway
Selkirk Mountains
Rogers Pass
Sir Donald Range
Bald Mountain
Battle Range
Main Battle Range
Clachnacudainn Range
Incomappleux River
Sixth Meridian
Fifth Meridian
Columbia River
Kootenay Central Railway
Kootenay Central Railway Branch C P R
Moro
Carbonate Landing
Parson
Spillimacheen
Spillimacheen River
Hobbie Burns Cr
Ross Peak 8606
Mt Green 8860
Mt Swanzy 7962
Bonney 10194
Flat Creek
Cambie
Glacier
Illecillewaet
Downie
Albert Canyon
Laureita
Albert 9621
Twin Butte
Greeley 7239
Mackenzie 8073
Carver 8563
Greenslide
Wigwam
Camborne
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Arrowhead
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Sroat 8024
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Cranberry Cr
Cranberry
Arrow Lake Br C P R
Illecillewaet River
Pacific Railway
Canadian Pacific Railway
Selkirk Mountains
Rogers Pass
Sir Donald Range
Bald Mountain
Battle Range
Main Battle Range
Clachnacudainn Range
Incomappleux River
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Fifth Meridian
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North Fork 8887
Cecil Rup 8982